Information Mapping & Structured Writing
The Early Research Documents

Robert E. Horn

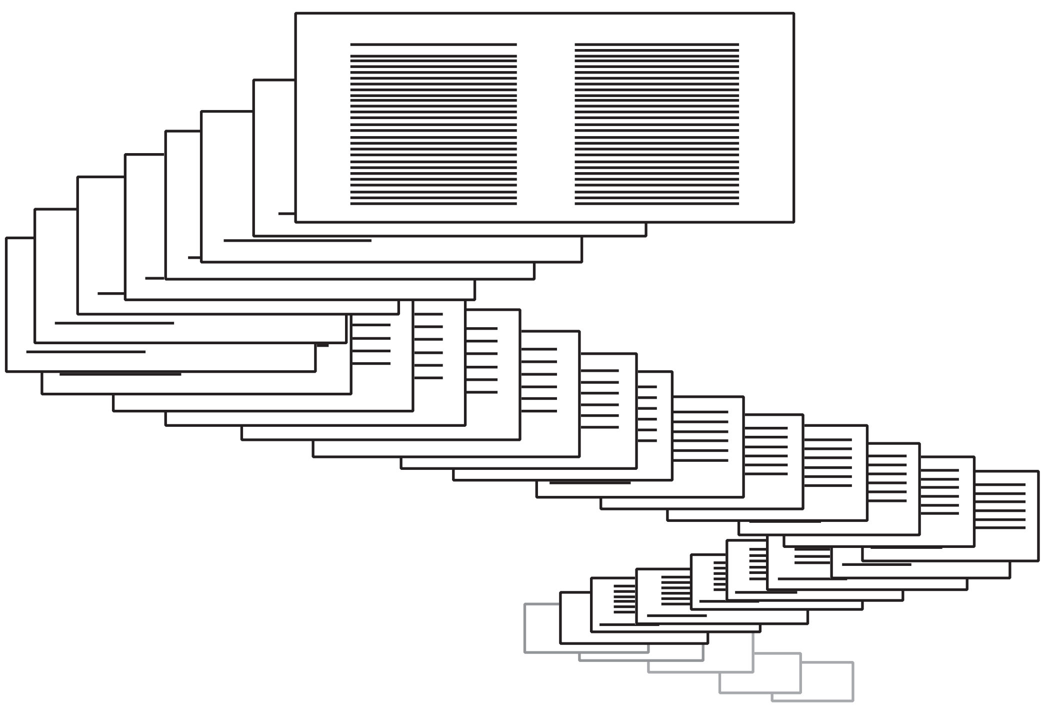

Table of Contents

Introduction

Research Leading to Structured Writing and Information Mapping

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Structured writing ideas begin at Columbia University
In 1964-65 at Columbia University's Institute for Educational Technology I developed the first ideas about information mapping and structured writing. I had decided that Skinner, one of the two or three most important psychologists of the 20th Century, did not have the right approach to learning and instruction. I would develop the real *science* of instructional materials. I had already worked for a computer company and been reading the research on cybernetics.

Search for a science of instructional materials
Skinner's suggestion of program learning was based on a simple methodology of identifying stimulus and response. As a young 30-year-old, brash and ambitious, I thought, "There is no science here. There is not even a taxonomy of the basic elements of instructional materials."

Linnaeus is my model for a taxonomy
If there was no science, then somebody like me would have to get started on it. I decided that I was the person to get started. My model was Linnaeus the Swedish biologist who created the first serious taxonomy of living things. When I looked at the field of instructional material I found no taxonomy. So, my first job was to create a taxonomy. But a taxonomy of what?

Individual instructional sentences were the items to be classified
At the time the primary instructional materials for most fields were textbooks. They represented what was known in a subject matter or discipline. And at that time, what were textbooks mostly composed of sentences. Of course, there were a few diagrams but in 1965 this was before the proliferation of diagrams that has since entered all kinds of instructional materials.

So, I decided that if sentences were the basic elements that one can see and identify, then we might need a taxonomy of sentences in instructional material. I got a friend of mine who was working in the publishing industry to give me two copies of different textbooks. I intended to cut apart the textbooks sentence by sentence and see if one could develop a taxonomy of the sentences themselves.

Sitting on the floor cutting apart textbooks
My wife recalls me sitting on the floor of our living room with a pair of scissors cutting apart textbooks and putting the sentences in little piles.

Functions performed by sentences was the key
I found that one could sort sentences from many different subject matters into their *functional* types. But I did not have a very clear idea initially of what I meant by functional types. However, I pursued the endeavor. The first finding was that machines and other kinds of structures had parts and were defined functionally in that way. I could put all the sentences that talked about parts into one pile.

Then there were a lot of sentences that performed functionally as definitions or examples. It was easy to sort all the sentences that contained definitions in another pile. That was easy because very often the sentences would say "An X is defined as…" Or "What is an X? It is a…with a…" And so forth. This was an amazing finding and as it turned out to a very useful as well

That is how I began to assemble a list of functions.

Larger functional groups of sentences
At that point I was very fortunate to have encountered excellent book (Upton A, and Samson, R.W., 1961, *Creative analysis*, E.P. Dutton) that came out of the field then known as general semantics. I knew about it because I had written a half of my book *Language Change and Communication* on that subject.

They suggested that large classes of sentences could be sorted into six categories:
• Structures
• Procedures
• Policies
• Processes
• Classifications
• Facts

That meant (to me) that my little piles of cut-apart sentences could be put into larger groups.

Concept analysis added
There was much work at that time on the teaching of concepts by using examples and non-examples to carefully teach generalization and discrimination by Jerome Bruner (and others). It had built on BF Skinner's notions of learning and teaching concepts by examples and non-examples. Using this work, I added "concepts" to the six categories of Upton and Samson.

About 38 to 40 kinds of "core" sentences
I ended up with about 38 to 40 different piles containing individual sentences which performed different functions in the textbooks. Anyone could allocate these into the larger classes that Upton and Sampson had suggested. I discovered that 80 percent of the sentences in what I called relatively stable subject matter (i.e. what appears in textbooks) could be sorted reliably into these categories.

Of course, at the time I thought that I was going to revolutionize the whole field of instructional materials. But the 40 categories were mainly useful because technical writers and those who wrote various training and reference documents in business and industry would find them very helpful in addressing new topics that they had to write about.

Becomes a consulting job, and then a company
This taxonomy and how use it to create documents, was initially called structured writing which continues to be the generic term for the field. Subsequently I began to call it the Information Mapping® method of structured writing and eventually led to creating a research company that eventually turned into an international consulting company.

Supplementary sentences for other functions
I also found that in textbooks there were sentences with other functions. These were overviews and reviews. They duplicated the primary functions in the taxonomy I was creating. There were introductions and background statements that did not focus on the key elements of the subject matter that a student had to learn. They duplicated it. So, I put them in a separate category which I called supplementary sentences for learning and reference.

Surveyed 400 domestic Federal programs
I left Columbia to become a consultant and designed and managed a database service (in those days a loose-leaf service) on Federal programs that Congress and President Johnson were passing into law at an astounding rate. The office I set up in D.C. surveyed and kept up to date information on over 400 Federal programs for education, training, and research. It was called *The Guide to Federal Assistance.*

The company, Information Mapping ®, Inc. is born
After Columbia, I taught the Information Mapping method in a course called Research Methods at the Harvard Graduate School of Education in 1967. My research on this method was subsequently supported for over four years by computer-based instruction research contracts from the US Air Force Systems Command, which thought of itself as the world's biggest technical school system.

The Information Mapping method becomes the de facto standard
The company was the central preoccupation of my work life for 20 years and has become international and the method is now distributed in some 20 countries. The Information Mapping® seminars have trained well over 300,000 writers in industry world-wide, and the methodology has become the de facto standard for technical writing and documentation around the globe. I have received two lifetime achievement awards from two different international organizations: the world's largest computer society, Communications of the ACM and the International Society for Performance and Instruction. The Information Mapping method is thus regarded as the preeminent version of the larger field of "structured writing."

1985-87 – I leave Information Mapping, Inc.

I had some serious health problems at the beginning of the 1980s. I decided that the stress of being CEO of Information Mapping, Inc. was life-shortening and, hence, not a very good idea. I sold most of the company and moved to the West Coast, and thanks to the sponsorship of Terry Winograd, I was (until retirement) a visiting Senior Researcher at Stanford University, at H-STAR Institute (the Human Sciences and Technology Advanced Research Institute) for 27 years.

Structured Writing as a Paradigm 1998

Structured Writing as a Paradigm

by Robert E. Horn

A chapter from Instructional *Development: State of the Art* edited by Alexander Romiszowski and Charles Dills, Englewood Cliffs, N. J., Educational Technology Publications, 1998

Introduction

Thomas Kuhn (1962) suggests that "normal science" consists of "research based upon one or more past scientific achievements that some particular community acknowledges for a time as supplying the foundation for its further practice." These achievements were (l) " sufficiently unprecedented to attract an enduring group of adherents away from competing modes of scientific activity," and (2) "sufficiently open-ended to leave all sorts of problems for the redefined group of practitioners to solve." He then states that this is his definition of a paradigm: "Achievements that share these two characteristics I shall henceforth refer to as paradigms." Although Kuhn goes on in the same book to use the word "paradigm" in at least twenty-one distinct meanings (as cataloged by Masterman, 1970), this is the only place where he explicitly defines the term. Others have broadened the meaning of "paradigm" and still others have used the term as a metaphor for "any theory or method or approach, large or small."

If any writing or instructional design approach can be called a paradigm within Kuhn's definition, I will claim that structured writing most certainly qualifies. And if Kuhn's concept of paradigm can be metaphorically extended beyond the sciences to the realm of practical methodology of communication, then structured writing surely qualifies there as well. My approach in this chapter will be to describe what I believe to be the salient characteristics of structured writing and to describe the "past achievements" that supply "the foundation for further practice." Then I will demonstrate briefly how these achievements have been "sufficiently unprecedented to attract an enduring group of adherents away from competing modes of scientific activity" and finally to describe some of the sorts of issues in the research and evaluation that structured writing focuses us on today.

1. What are Some of the Problems that Structured Writing Addresses?

Structured writing has been developed to address many of the perennial problems most people have when working on a complex written communication task. Instructional design certainly qualifies as such a complex task. Some of these perennial problems are:

- How should I organize the mass of subject-matter material?
- How can I keep track of the structure? How can the reader keep track?
- How can I make the structure of the document and the subject matter more obvious?
- How do I analyze the subject so that I am sure that I have covered all of the bases?
- How do I know the coverage is complete? How will the reader understand this scope?
- In large analytic and communication tasks, how do I track multiple inputs, different levels of reader competence and rapidly multiplying and increasingly demanding maintenance requirements?

- If I am working in an organization with a large number of writers, how do I provide the plan for a group of writers and how do I manage the group -- efficiently --so that it will appear to the reader that there is a unity or organization, structure, analysis, style, graphic display and format?
- How do I sequence the final document so that it will present the information to different levels of readers in the most useful manner?
- How do I organize the linkages so that different readers with different backgrounds can get what they want from it easily and quickly?
- What formats are optimum to enable users to make sense of the document as a whole and through the window of the current display?
- How do we make instructional writing optimally effective and efficient?
- These problems are not unique to instructional design. They are addressed one way or another by every person who writes a document. But they are the major issues faced by the paradigm of structured writing. The remainder of this chapter will examine how structured writing helps writers tackle these questions.

2. What are Some of the Presuppositions of Structured Writing?
In this section I will present several of the major presuppositions of structured writing to provide the background that I used to formulate the paradigm of structured writing.

I have used these presuppositions without entering current cognitive science debates as to whether or not we really use some kinds of representations within our minds and brains. Rather, I simply observe that when we communicate, we do use representations.

Presuppositions about Subject Matter. I began with what seemed obvious, namely that, since we communicate with each other using physical mediums we have to represent what we do in sentences and images. Thus, any subject matter consists of all the sentences and images used by human beings to communicate about that subject matter. So, with sentences and images, we have all we need to fully analyze a subject matter. I acknowledge that subject matters exist that can only be learned by intense observation, practice and nonverbal feedback (such as an exotic martial arts). I acknowledge the issues raised by Polanyi in his concept of tacit knowledge, i.e. that certain knowledge is learned by observation of fine motor movements and unvoiced values, which go beyond the sentences that represent a subject matter. But I sidestep them. Structured writing only deals with that which can be written. Practical communication in commerce, science, and technology teaches, documents or communicates something. Therefore, I assume that what is important enough to learn is capable of being rendered in sentences (or diagrams).

I also assumed that the most important regularities to understand in a subject matter are those that exist between sentences. Many of the studies of language begin and end with the study of words and sentences in isolation. Subject matters are tight relationships between many clusters of sentences and images. So, if we are to analyze subject matters properly (i.e. efficiently and effectively) for communication and training, we must understand the relationships between sentences. Why is it that certain sentences should be

"close" to each other in an instructional document in order to convey the subject matter easily to a new learner?

Presuppositions about readers. There were a number of assumptions about the users (or readers). I took it as axiomatic that different readers and learners may want to use a given document in a variety of ways. Readers may use any of the following approaches to a given document: scanning to decide whether to read the communication at all, browsing to find interesting or relevant material, analyzing critically the contents, studying to be able to remember the subject matter, etc. And, in general, it is difficult to predict what learners and readers will do with a given piece of instruction or communication. Documents often have hundreds or even thousands of users. Each document has a different interest and relevance to each user. Each must therefore serve many people having many purposes. If possible, it is important to optimize among several functions in the same document.

Presuppositions about Writing. When I developed structured writing, I also introduced what turned out to be a fairly radical assumption: *A new paradigm in communication and learning* requires a new basic unit of communication. Revolutions in paradigms in physical theory have in part come about from the different concepts of the most basic particle (the atom as a singular unit, Bohr model of atom as a subvisible solar system, electrons as rings of probability, to the discovery of subatomic particles, etc.). Revolutions in linguistic theory came about with the invention of grammar as a unit of analysis. The behavioral paradigm in instructional design came after Skinner's invention of the stimulus - response unit. Similarly, the invention of the information block (discussed below) qualifies as a major turning point in the history of the conception of basic units.

Most training is not formal training. It does not take place in the classroom with documents called training manuals. It takes place on the job with whatever documentation is at hand. I have heard that only one-tenth of training is formal classroom training. Nine-tenths never gets accounted for in the financial or other reports of a company as training. Thus, in my list of major assumptions is this one: Anything that is written is potentially instructional. Therefore, in so far as possible: A writer should design each communication to potentially be "instructional" even if its ostensible job may be as a memo or a report or as documentation.

Another focus on the structured writing presuppositions began is giving importance to the scientific research on how much people forget. We forget, as I am sure you remember, most of what we learn within three weeks of learning it. At that time, I noted that we must build "learning - reference systems" in order to deal with these problems. (Horn, et. al., 1969) . Since then we have used the term "reference based training" (Horn, 1989a) to cover this area. Others have invented the delightful term "just in time training" to cover an essential aspect of this training need. And later I specified the domains of memos and reports as another arena in which writing with instructional properties takes place. (Horn, 1977)

With this survey of the assumptions underlying the paradigm, let us take a look at the actual components of the structured writing approach.

3. What Are the Components of the Structured Writing Paradigm?

My early (Horn, 1965) analyses began with the detailed examination of actual sentences, illustrations, and diagrams that appeared in textbooks and training manuals. My investigation involved trying to establish a relatively small set of chunks of information that are (1) similar in that they cluster sentences (and diagrams) that have strong relationships with each other and (2) that frequently occur in various kinds of subject matter. This analysis focused, thus, on the relationship between the sentences in subject matter. The result of this analysis was the invention of the information block as a substitute for the paragraph. The taxonomy that resulted is now known as the information blocks taxonomy for relatively stable subject matter (shown in Figure 1).

Figure 1
Most Frequently Used Block Types
(in domain of relatively stable subject matter)

Analogy	Description	Notation	Specified Action Table
Block Diagram	Diagram	Objectives	Stage Table
Checklist	Example	Outlines	Synonym
Classification List	Expanded Procedure Table	Parts-Function Table	Theorem
Classification Table	Fact	Parts Table	When to Use
Classification Tree		Prerequisites to Course	WHIF Chart
Comment	Flow Chart	Principle	Who Does What
Cycle Chart	Flow Diagram	Procedure Table	Worksheet
Decision Table	Formula	Purpose	
Definition	Input-Procedure-Output	Rule	
	Non-example		

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Definition: Information Blocks

Information blocks are the basic units of subject matter in structured writing analysis. They replace the paragraph as the fundamental unit of analysis and the form of presentation of that analysis. They are composed of one or more sentences and/or diagrams about a limited topic. They usually have no more than nine sentences. They are always identified clearly by a label. Three examples of information blocks are shown in Figure 2. Information blocks are normally part of a larger structure of organization called an information map (see below for explanation of maps). In short, they are a reader-focused unit of basic or core parts of a subject matter.

Example of an Information Block

What do information blocks look like? It is important to notice that different types of blocks vary widely in appearance and construction. For example, below is one of the most simple-looking types of blocks (but one that has standards for construction more stringent than most), a definition block:

Definition. The Master Payroll File is a group of records containing all of the payroll and employee information used by the weekly payroll program.

How is a Block Different from a Paragraph?

Let us examine some of the characteristics of this example of an information block and see how it differs from paragraphs. First, we must note that there is no topic sentence in the information block. Topic sentences are absent or irrelevant in much of structured writing, so much so that they are not taught in a structured writing course.

Second, it is worth observing that there is no "nice to know" but irrelevant information in the information block. Note that the only information it contains is information that is relevant to defining the term Master Payroll File. Paragraphs typically have a lot of nice to know information.

Third, note that the block has a label. One of the mandatory requirements for blocks is that they always have a distinguishing label, chosen according to systematic criteria (Horn, 1989a). Paragraphs have no such requirement, although they may be randomly labeled, depending upon the taste of the writer.

Fourth, All definitions in a given structured document would be consistent with these characteristics. Paragraphs have no requirement for consistency within or between documents. These are some of the main characteristics that distinguish the block from a paragraph.

This first example is a very simple block. While this block is one sentence long, many types of blocks contain several sentences. diagrams, tables or illustrations, depending upon their information type. (See Figure 2) Typical blocks are several sentences in length, and might contain different kinds of tables: Diagrams comprise other kinds of information blocks.

Figure 2
Some Different Kinds of Information Blocks

Information Block Containing a Table

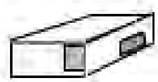
Decision

IF the book is	THEN send the patron	AND send . . .
available	the book	an invoice to the Billing Unit
not available - never owned - lost	Form 25	—
checked out with no waiting list	Form 66	a copy of Form 66 to Circulation Desk.
checked out with a waiting list	Form 66 and Waiting List Notice	a copy of Form 66 to Circulation Desk.

Information Block Containing One Sentence and One Diagram

Diagram

The terminal is held in place in the connector cavity by a locking tang. The attached cable allows you to move and position the terminal.



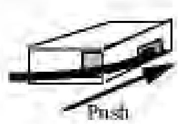
Information Block with Several Sentences and Several Diagrams

Procedure

Step 1

Push the cable forward until it will no longer slide.

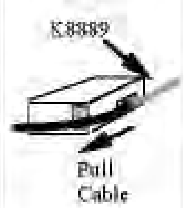
Example :



Step 2

Insert the K8889 tool through the hole on the opposite side and gently pull the cable out.

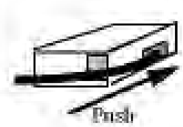
Example :



Step 3

Inspect the terminal. Replace if necessary and then replace the cable by inserting is into the locking tang.

Example :



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How Does Structured Writing Handle Cohesion and Transition?
There is no "transitional" information in the information block, but principles for writing prose encourage or require it. The need for coherence, cohesion, and transition is handled in a completely different manner in structured writing. While this is a huge topic, (Halliday and Hasan, 1976) suffice it to say that much of the burden of coherence is placed on the labeling structure and much of the transition requirement is placed on one type of block, the introduction block, that frequently appears at the beginning of information maps.

The Four Principles
All information blocks are constrained by four principles used to guide structured writing:

The first of these is the **chunking principle.** It derives from George Miller's basic research (Miller, 1957. See also note 2) which suggest that we can hold only 7 plus or minus 2 chunks of information in human short-term memory. Our formulation of the principle states: Group all information into small, manageable units, called information blocks and information maps. Small (in information blocks) is defined as usually not more than 7 plus or minus 2 sentences. While others lately (e.g. Walker, 1988) have recommended modularity (i.e. dividing information into labeled chunks) as a principle of structured writing, I have insisted that information blocks turn out to be "precision modularity" (Horn 1989a, 1993) because of the operation of three other principles with the chunking principle and because I believe we have shown that blocks sorted using our taxonomy (see below) offer much greater efficiency and effectiveness of composition and retrieval.

The second principle we use in helping to define the information block is the **labeling principle.** It says: Label every chunk and group of chunks according to specific criteria. It is beyond the scope of this paper to get into all of these criteria. They consist of guidelines and standards some of which cover all blocks, some of which cover only specific types of blocks or even parts of blocks. I have claimed elsewhere (Horn, 1992a) that it is the precise specification of different kinds of blocks that permits the identification of context and limits for these criteria, thus saving them from being bland and overly abstract, and, thus, largely useless, guidelines.

The third principle used in developing the information block is the **relevance principle.** It says: Include in one chunk only the information that relates to one main point, based upon that information's purpose or function for the reader. In effect it says, if you have information that is nice to know, or contains examples or commentary, the relevance principle demands that you put it some place else and label it appropriately: but do not put it in the definition block.

The fourth principle is the **consistency principle.** It says: For similar subject matters, use similar words, labels, formats, organizations, and sequences.

Answering Some Objections to Blocks

Some have commented that information blocks are not particularly unique or novel. They say, for example, that information blocks are only what paragraphs, when written properly, should be. I have answered many of these claims elsewhere (Horn, 1992a). If extraneous information is excluded from an information block (as it should be, following the relevance principle) the discourse is changed radically. If the materials for cohesiveness and transition in paragraph-oriented writing are put into the labels and if the labeling system is relevant and consistent, the appearance and usefulness of the whole piece of writing is changed tremendously. If the subject matter is divided into appropriate-size of chunks (using the chunking principle and the taxonomy of information blocks), the form of discourse is changed decisively. If all of these changes are made together in the same document, the text usually has much less intertwined prose with multiple threads and allusions. It is a far more usable text to scan, to read and to memorize.

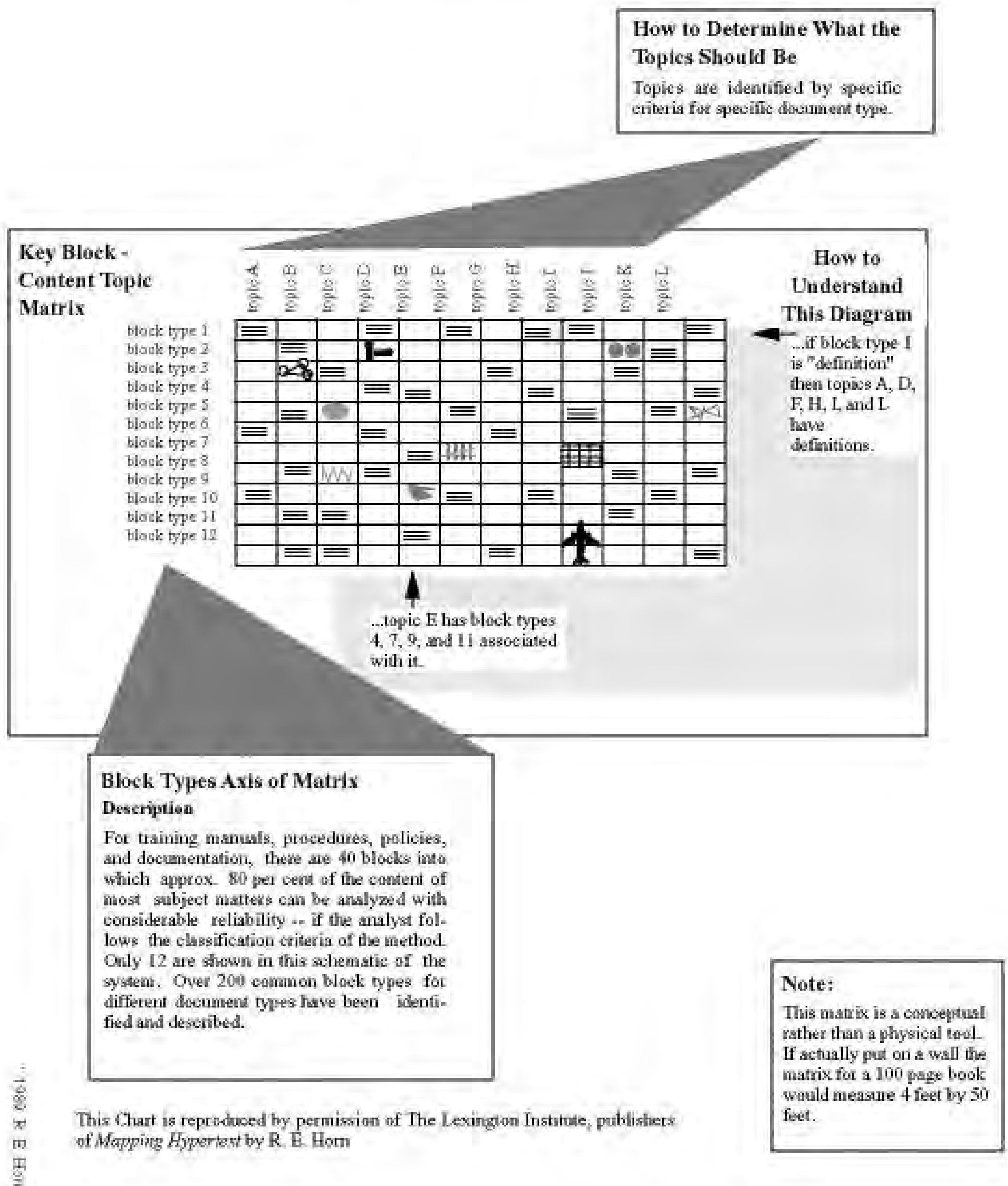
Blocks by Themselves Qualify Structured Writing as a Paradigm.

By itself, the invention of the information block might qualify structured writing as a separate and new paradigm for analysis and writing. But we used these new distinctions to build a powerful analytic tool for gathering information about and specifying the subject matter in instructional or documentation writing. Simply revising the basic unit has radically shifted the rhetoric of exposition in the documents in which structured writing is used.

Topic - Block Matrix of a Subject Matter

To aid analysis of subject matter for instructional and documentation purposes, I conceptualized the subject matter as a topic - block matrix, shown schematically in Figure 3.

Figure 3
Block Type - Content Topic Matrix



The reader will note that the topics from the subject matter are arranged along the top of the matrix. This is done according to a group of guidelines provided as a part of the structured writing system. The block types (see Figure 1 for list) are arranged along the vertical axis. The resulting cells in the matrix represent information blocks into which the

sentences and diagrams from the subject matter are placed. Examination of the blank spaces show the analyst what information may still be not written down and hence perhaps not known. Specific templates have been developed which permit the analysts to know with a high degree of certainty which block should be filled in for a specific topic. An example of this would be a template which would specify these three block types for a concept: definition, example, and (optionally) non-example.

Systematic Labeling

Another key component of structured writing was the development of a system of consistent labeling of parts of a document. Obviously labeling is not unique to structured writing. Many books follow a more or less systematic labeling guideline. But when combined with the new units of communication, the information block and the information map, the systematic labeling becomes a powerful communication device. In a recent article (Horn, 1993) I summarized the benefits of such a systematic approach to labeling. Systematic labeling:

- enables readers to scan content to see what they want to read
- enables readers/learners to to find what they are looking for in a consistent, relevant, complete manner;
- enables the analyst/writer to manage the intermediate stages of information gathering and analysis in a more efficient way;
- enables learners to anticipate learning problems by showing the structure of the subject matter to them."
-

Definition: Information Maps

Information Maps are a collection of more than one but usually not more than nine information blocks about a limited topic. In general, one can think of an information map as approximately one to two pages in length, but some maps (of certain well-specified types) run several pages in length and some maps are composed of only one information block. Maps both (1) aid the writer in organizing large amounts of information during the analysis phase and (2) help the reader to understand the structure of the subject matter and the document. Maps may be sequenced hierarchically or in other clearly defined ways such as task or prerequisite order. Maps are assembled during the sequencing phase of the writing process, into parts, sections, chapters and documents depending upon communication purpose and reader needs. (For an example, see Figure 4.)

Figure 4

Example of an Information Map

Comparing 17.1.0	**Regular Data Values, and . . .**	**Non-Regular Data Values**
Introduction	Some data have patterns. They progress by fixed increments.	Some data do not show any pattern of intervals between the values.
Definition	Data are called regular when the values of a data vector progress from some initial value with some fixed interval to another value, and then optionally from that to still other values by even increments.	Data are called "non-regular" data when they have no systematic pattern of intervals between them.
Example One	Time data show frequent regularities. Samples of blood collected from a laboratory animal every hour on the hour might be called SAMPLEHRS and might look this way: SAMPLEHRS = 6, 7, 8, 9, 10	Most measurement data do not exhibit systematic regularities that are fixed intervals between values, so they are usually non-regular data. Here is an example: LABMEAS - .01, .09, .04, .3
Use This Input Statement	Input with Computed Clause Statement	Standard Input Statement
Comment	This statement permits you to input regular data in a very compact form and is much quicker to type than a normal input statement.	This statement should be used for normal data entry.
Related Pages	Input with Computed Input Statements, 22 Standard Input Statement, 21 Variables, 19	

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Discourse Domains

Communication in business takes place in some fairly routinized forms. This fact enables us to identify some major domains of discourse. We begin such an analysis by asking questions about specific domains such as: How does a report of a scientific experiment differ from a sales presentation or a policy manual? They differ in many ways. They differ as to who the authors are, how the authors have come to know the subject matter, what can be assumed about the audience of the communication, what level of detail is used, what content is communicated.

In addition to the "what are the differences" questions, we can ask the "what are the similarities" questions. How are all reports of scientific experiments alike? How are all sales presentations alike? The analysis of these similarities and differences is what is called domain analysis in structured writing. It involves examining the relationships between author and reader of different kinds of documents and the "stances" and points of view that can be seen as a result. This analysis yields specific block types that can be expected in specific kinds of documents. The domain of relatively stable subject matter has already been introduced in this chapter as the one that comprises the subject matter used in training and documentation writing (see also below).

So, in the Information Mapping method, a domain of discourse is defined as the specification of information blocks of a particular class of documents, all of which share the same type of author-reader assumptions and the same stance or point of view towards subject matter.

Some examples of domains of discourse (Horn, 1989a) have been studied extensively. They are:

- the domain of relatively stable subject matter, which is that domain of subject matter which we think we know well enough to teach it in a course or write an introductory training material about it.
- the domain of disputed discourse, which is that subject matter about which we know enough to chart its disagreements.
-

Other domains such as those of business report and memo writing have been studied (Horn, 1977) Still others remain to be carefully identified and mapped.

Information Types

Blocks in the domain of relatively stable subject matter can be sorted into seven basic classifications, which we call the "information types."

The seven information types are:

- Procedure
- Process
- Concept
- Structure
- Classification
- Principle
- Fact

This is a key set of categories for specifying and describing how human beings think, especially about what we have called relatively stable discourse domains. Structured writing guidelines have been developed that permit the information blocks to be assigned to one or more of these information types. An example would be the assignment of definitions and examples to the information type "concept" or the assignment of a flowchart to the information type "procedure." This permits the identification of what has come to be called "key block" information, the information which you must have to fully analyze an individual topic of a subject matter. Key blocks enable writers to anchor their writing firmly and reliably to the centrally important structure of a subject matter. (For further information, see Horn, 1989a, Chapt. 3)

The information types theory is used to help the analyst/writer identify specific information that is needed for each topic. These information-type templates specify the key information blocks needed to ensure completeness and accuracy of the analysis.

Systematic Integration of Graphics

From its conception, the structured writing paradigm recognized the importance of graphics (illustrations, diagrams, photographs) as an integral part of any writing with a practical purpose. This meant that we had to specify exactly where such graphics would communicate better than words by themselves. And this led to the identification of specific blocks within the overall scheme which are required to have some kind of graphic, because the communication was likely to be better than if the same message were conveyed only by words. This is also paradigmatic change. Certainly in the past words and images had been used together. But graphics were regarded either as a "tacked on" afterthought or as decorations, not as a mandatory and integral part of the message. (see Horn, 1993 for a fuller treatment of this point).

Systematic Formatting

Much reading in the Age of Information Overload is actually scanning. We must continually identify that which we don't have to read. We are always looking for the salient parts. This makes the requirement for aiding scanning paramount in the specification of formatting. There have been a variety of formats identified that meet this criteria. Structured writing is most often associated with a single format: that of having the map title at the top and the block labels on the left-hand side of the page. But this is only one of the many possible formats of structured writing that aid scanning (see Horn, 1989 for others). The topic of formatting is also the one that has produced the most confusion about structured writing. Many people have observed only the strongly formatted versions of documents written according to the analytic methods of structured writing and have concluded that "it is only a format." Since the analysis and structuring of the document is part of the process of producing the document, much of the highly disciplined thinking that goes into producing the documents is not immediately visible. But the number of trained writers of structured writing has grown to over 150,000 world-wide, and the discernment that something more than format goes into structured writing has gradually become the norm rather than the exception.

Systematic Life Cycle Approach to Document Development

Documentation and training materials often last a long time. The amount of time from drafting to final discard of a document can be years and sometimes decades. Many business documents are frequently revised and updated. This means that a methodology for writing must have in place a facility for rapid revision and updating as well as cost-effective initial development. The structured writing paradigm has made paradigmatic changes in how documents can be updated and revised. Because the basic units of organization, the information blocks, are easily isolatable from each other (unlike other paradigms of writing and formatting), they can be much more easily removed, changed or replaced. Previous and more literary rhetorics provide a great deal of difficulty to the writer managing the life cycle of the document, because such literary rhetorics have an intricate and highly interwoven approach to organization. Managers involved in preparing foreign language translations also report major efficiencies of translation because of the simplification of rhetorical structure. Needless to say that the structured writing approach propagates rapidly in a business environment in which costs of publication are closely watched.

What Structured Writing Shares with Other Paradigms

Not all of the components of structured writing are novel. Such total novelty is not a requirement for a paradigm. Structured writing shares the use of words and sentences with other forms of writing. Many of the conventions and rhetorical guidelines for good, clear writing of sentences are incorporated without change. Moreover, when serving a purely instructional function, most of the guidelines regarding the design of practice exercises, tests, criteria-based instruction, etc. are used wholesale.

Behavioral research from instructional design, such as Merrill's and Tennyson's (1977) work on teaching concepts, has also been incorporated into the structured writing paradigm. This research serves to strengthen the instructional properties of documents whose initial or primary use is not instructional, but which at some time in the life cycle of the document must provide formal or informal training. Moreover, as another example, much of the collection of research-based design imperatives in Fleming's and Levie's (1978) work on message design supported and strengthened the research foundations of the structured writing paradigm, as have many individual pieces of research since then.

4. What Makes Structured Writing "Structured?"

One of the claims of structured writing is that there exist particular dimensions along which technical or functional writing can be described (if observing it from the point of view of an outside observer) or composed (if attempting to develop some document using it). It seems to me that we can describe several scales of structure or dimensions along which a piece of prose would be placed. Some of these scales are:

The Chunking Scale. This scale might be described by the question "to what degree can the between-sentence units be clearly chunked into separate chunks, each of which serves only one purpose?"

Most ordinary prose paragraphs would be placed on the low end of this scale simply because they mix functions. For example, many paragraphs mix introductory and definitional functions, while highly structured writing keeps them separate. I have itemized and described forty such functions for chunks (which I call information blocks) appearing in the domain of relatively stable subject matter (the domain of text books, procedure and policy manuals, etc.). Dividing subject matter strictly according to this taxonomy of chunks produces highly structured chunking.

Making the structure visible with labels. Does such a highly chunked writing style produce highly structured writing? To some degree it does. But there are other dimensions to consider. One of these has to do with whether or not the reader can actually see the structure by glancing at the page. Three factors contribute significantly to making the structure visible.

One factor is whether or not the chunks are labeled. If the chunks are clearly and functionally labeled the reader will be able to scan the labels and get a gist of the document as a whole. The second factor is actually a group of design elements that include format (where the labels are placed) and type style (such as size and boldness of the labels). A third factor is whether there is a systematic application of labeling -- the application of the consistency principle.

So we have three more possible scales or dimensions of "structuredness" to consider. Clearly most prose falls down badly on these scales, while methods that have a labeling system will be rated as more "structured." And to determine "structuredness" we must use a multi-dimensional approach.

The Between-Chunk Sequencing Structure All of the dimensions of structure discussed so far could be done and we might rate the writing as poorly structured, because the way in which the chunks are put together does not present a clear structure to the reader.

There are many ways to arrange the sequence of chunks in a piece of writing. For example, arranging them hierarchically is one frequently used way . here again there are at least two distinguishable factors: (1) is the document organized according to some larger organizing scheme, such as the concept of nine different kinds of hypertrails as a basis for the structuring of sequencing (Horn, 1989a) and (2) can the reader see this at a glance? So again we have both the "inner organization" principle and the formatting principle at work.

These and other "dimensions" and their attendant scales might be devised to make a precise determination of structuredness in individual pieces of writing. (See Note 4)

5. Is Structured Writing "Sufficiently Unprecedented" and Has It Attracted an "Enduring Group of Adherents?"

Kuhn suggests that the paradigm must show achievements that were (l) " sufficiently unprecedented to attract an enduring group of adherents away from competing modes of scientific activity."

Structured writing also qualifies as a paradigm in that it was presented all at once as a complete methodology, rather than incremental additions. This is not to say that no improvements or additions have been made. The major structures and components of structured writing have endured over 25 years (Horn, 1993) To review, the components that appeared together all at once are:
-The invention and description of the information block as a new kind of basic unit of communication that permits the use of truly structured writing;
-The precise specification of different kinds of information blocks for specific purposes, and in particular the specification of approximately 40 information blocks that comprehend over 80 percent of the domain of relatively stable subject matter and the specification of other clusters of block types for memos, reports, proposals and other document types;
-The invention of a content analysis approach of question and information types that clusters different information blocks to guide question asking and ensure completeness in the initial analysis of the subject matter;
-The invention and description of an intermediate unit of structured writing, the information map, that permits easy and natural topic clustering;
-The development of a comprehensive and systematic set of criteria for labeling blocks and maps;
-The systematic specification of where graphics should be used and where text would be better;
-The development of easy-to-scan formats that exactly fit with the analysis methodology and categories to aid learning and reference.

We have already described how these different characteristics and components represented dramatic departures from the customary practice at the time structured writing was introduced. Even today the conventional literary approach is still taught in most writing and instructional design courses, although many technical writing courses are adopting some kind of structured approach.

In recent years, the group of adherents to the structured writing paradigm has been growing by approximately 20,000 persons annually (Note 3). The total number of users stands somewhere around 150,000 as this chapter is written. These are primarily people in industry: instructional designers, people who write documentation and reports, managers who write memos and proposals, developers who build online and hypertext applications. Many of these people are taught in the largest companies in the world by a licensing arrangement (Note 3) which qualifies instructors to teach within a company that has made a commitment to training all of the relevant staff in the methodology. A considerable group of researchers has focused attention on the structured writing methodology as well (see next section). Altogether one can confidently note that structured writing has attracted an "enduring group of adherents."

6. Is Structured Writing Sufficiently "Open-Ended" for Research and Practical Application?

Kuhn's definition of paradigm requires that the theory be " sufficiently open-ended to leave all sorts of problems for the redefined group of practitioners to solve." Structured writing qualifies by this criteria in that it has produced a robust, ongoing stream of research and evaluation both in universities and in industry.

One test of this requirement is to ask if there have been major problems solved within the methodology after the initial paradigm was presented. There have been several. In 1977, a major extension of the methodology was made to the crafting of memos and reports. (Horn, 1977) Here the concept of the information block was kept intact, but a new domain was surveyed which resulted in the identification of fifteen basic types of reports and memoranda in industry and the identification of blocks that acted analogously to the key blocks in the domain of relatively stable structured subject matter. The formatting was modified and extended to incorporate requirements of the report and memo contexts. The idea of the map was modified in several ways while keeping its major purpose and the systematic criteria for the labeling of blocks was extended slightly.

A similar major extension was made in 1988 (Bellerive and Horn, 1988) by extending the approach to the preparation of proposals. Most of the major extensions used for reports were reexamined and found appropriate for proposals. A few modifications were made in the basic methodology to adapt it to the proposal context in industry. Similarly in 1989, the approach was applied to writing for computer user documentation (Horn, 1989b).

The structured writing approach has been shown to be analogous to other types of structured methodologies and can incorporate them into its larger dominion. One such area is argumentation analysis (Horn, 1989a, Chapter 7) which enables analysts to examine the form of argumentation presented by an author or speaker at various levels of detail in a diagrammatic way.

Another dimension of open-endedness should also be noted. From the beginning, I made no effort to complete the methodology. I have always said that the taxonomy of 40 information blocks for relatively stable discourse covers eighty percent of the subject matter. Why only try to achieve eighty percent? Why not attempt to identify ninety-nine percent of the information block types? First, eighty percent coves a lot of territory. Since key blocks which identify the core information in a subject matter, fall among this eighty percent, the most fundamental information is guaranteed to be there. Secondly, it would not be cost effective to try to specify all of the rest of the blocks. They tend to be idiosyncratic to particular subject matters and instructional contexts. Rather, I decided to go up a level of abstraction at that point and develop criteria for making new information blocks. What the writer does about the other 20 percent is to devise new block types. I used this open-endedness in my proposals to improve the writing of scientific reports and abstracts (Horn, 1989a, Chapter 8). Others have taken this approach in literally thousands of situations in writing industrial applications. This approach provides a continuous open endedness to the methodology. I might also mention that, in a similar area, writers are encouraged to combine different kinds of maps to suit the document they are creating.

A recent survey (Horn, 1992b) notes fifteen doctoral dissertations that focused on structured writing. One reviewer (Clark, 1993) was "surprised to see that most of the research done on the method has evaluated its effectiveness on learning outcomes, not retrieval speed or accuracy." (That was not surprising to me since the structured writing paradigm grew out of the instructional design context, not the conventional writing context.) Clark continued "Of the ten studies summarized (in detail in Horn 1992b), seven focused on learning and only two on retrieval time. In the learning studies, most compared the effectiveness of (structured writing) with 'conventional' materials on test scores. In two of the studies time was controlled; in the others learners studied as long as they wished." Figure 5 shows the results of the studies summarized in Horn 1992b. Clark concluded "It seems that there is fertile research soil to till with future studies that focus on speed and accuracy of retrieval from large reference documents prepared using various layouts. More cognitively-oriented research that includes protocol analysis while learners read would help to document not only effectiveness but get insight into the reasons for the effectiveness. Certainly reduction of cognitive loading would be one reasonable hypothesis to explore in comparing structured to conventional reference materials."

Figure 5

Results of Major Research Studies on Structured Writing

		Measured by Number Right or Errors	Time to Do Task	Supervisor Appraisal
Initial Learning	**Immediate Recall**	Stelnicki: 32% higher scores on facts; 41% higher on concepts Soyster: 13% higher scores Romiszowski: 10% higher scores Burrell: 53 - 59% better on tests Webber: 38% higher scores on the criterion tests	Romiszowski: 10% faster Webber: IM version was 50% faster	
	Long Term Recall	Soyster: No difference (attributed to motivation factors by the researcher)* Webber: IM version provided 85% or better accuracy when **starting** on the job.		
Retrieval	**Had Previously Used the Materials**	Jonassen & Falk: 33% higher scores with IM	Baker: IM had 12-21% better reading speed	
	Had Never Seen the Materials Before	Schaffer: 54.5% fewer errors with IM		
On-the-Job Application			Holding: Supervisors reported 32% de- crease in reading time for persons receiving reports written in IM. 84% of IM users report increase in writing speed after taking course.	Holding: Supervisors reported 100% of those who received training had producti- vity increase. Course was rated: ¥ very effective 63% ¥ effective 30% ¥ somewhat effective 7%

Key:
IM = Information Mapping's method
Names are names of principal investigators on specific research studies.

This Figure is reproduced with permission from the Lexington Institute, publishers of *How High Can It Fly? -- Examining the Evidence on Information Mapping's Method of High-Performance Communication* by Robert E. Horn

Many companies have now trained thousands of people in the structured writing methodology. More studies are needed to examine the impact of implementing the method throughout an entire organization. One such study (Holding, 1985) studied the impact of training 180 managers in structured writing seminars at Pacific Telephone. She looked at both the results on the writers and the readers (by interviewing their supervisors). On the writer side, there were decreases in writing time and increases in clarity, as well as improvement in analytical and organizing skills; which is not surprising given the extreme focus on analysis and organization in structured writing courses. All of

the supervisors surveyed stated that the amount of time it takes to read a document, using the method taught in the structured writing course, decreased. The mean decrease in the amount of time was 32 percent. Other advantages the supervisors reported included faster approval (of reports and memos) due to the methods used in the course (83%) . The supervisors and writers agreed that writers wrote their required letters and memos before deadlines. Further research along these lines would prove useful to other implementers.

The structured writing field has generally had to rely on research from cognitive psychology, educational research, and other fields for the close examination of its components and writing guidelines. There is a rich vein of potential research in this area as well. I have noted elsewhere (Horn, 1992a) that, while research in naturalistic settings such as jobs, classrooms and laboratories are important those settings may be the "wrong place to attempt to measure certain effects." I urged the field to devote more research time in the next phase of research to isolating variables . It would, for example, be helpful to know how much of the dimensions of "structure" contribute to the overall effects.

There is virtually unanimous agreement that much of what we read will be stored on computers in the next ten years. That conversion to online access and reading is proceeding steadily and is expected to accelerate. The availability of hypertext functions provides many opportunities for just-in-time instruction, but also provides managers with a panoply of problems (see Horn, 1989a, Chapter 2 for a survey of these problems). I have claimed that structured writing will help solve a good many for these problems (Horn, 1989a, Chapter 5).

It would seem that structured writing easily meets Kuhn's criterion of being "sufficiently open-ended to leave all sorts of problems for the redefined group of practitioners to solve" while at the same time providing practical solutions to today's busy instructional design practitioners.

#Notes

1. The primary source of training in structured writing is Information Mapping Inc. (Address: Information Mapping, Inc., 300 Third Avenue, Waltham, MA 02154; phone: (617-890-7003)

2. Originally I took Miller's dictum of 7 plus or minus 2 quite literally. Subsequent research on chunking has indicated that the ideas must be retained but in using them as a basis for structured writing guidelines, to consider them on a more metaphorical basis.

3. The estimate includes only those taught structured writing by Information Mapping, Inc. the major company teaching the methodology through its seminar division and its international licensees in the U. S., Japan, Australia, New Zealand, Mexico, and Europe.

4 In Information Mapping's method of structured writing, I generally set the standard toward the most highly structured end of the various dimensions and scales I have suggested in this article.

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INFORMATION MAPPING FOR LEARNING AND REFERENCE

Robert E. Horn, et al

Information Resources, Incorporated
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August 1969

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COMMAND SYSTEMS DIVISION
ELECTRONIC SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
L. G. Hanscom Field, Bedford, Massachusetts

(Prepared under Contract No. F19628-68-C-0212 by Information Resources Incorporated, 96 Mount Auburn Street, Cambridge, Massachusetts 02138.)

140

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FOREWORD

One of the goals of the Air Force Electronic Systems Division is the development of design principles and specifications for automated training subsystems which could be built into Air Force information systems and used for on-the-job training of system personnel. These instructional innovations are aimed towards providing the improved coupling of training and operations which is essential for effective use of information systems.

Task 280104, Computer-Aided Instruction Techniques, under Project 2801, Information System Design Technology, is directed towards the fulfillment of the above technical need. This report is one in a series supporting that task. It presents research on new techniques for formatting and sequencing information in training subsystems. Although the principles involved are applicable to conventional, hard copy information display such as in military manuals, the research is aimed towards specifications and future experimental applications in dynamic, generative information displays sequenced by computer.

The study was performed between May 1968 and July 1969 under Contract F19628-68-C-0212 with Information Resources, Incorporated, Cambridge, Massachusetts, by Robert E. Horn, principal investigator, Elizabeth H. Nicol, Joel C. Kleinman, and Michael G. Grace. The Air Force task scientist and contract monitor was Dr. Sylvia R. Mayer.

This report has been reviewed and is approved.

Sylvia R. Mayer

SYLVIA R. MAYER, Ph.D.
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Chief, Command Systems Division
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ABSTRACT

Information mapping is a method of organizing categories of information and of displaying them for both learning and reference purposes. The method may be applied to the production of self-instructional books or to the organization of data bases for computer-aided instruction and reference. This report is itself written in modified information map form. The procedures and rules for information mapping were derived from educational research and technology as well as from the communications world. The emphasis is on formats to communicate quickly and to facilitate scanning and retrieval. The research and development work reported here deals with the book form of a twelve-hour course on sets and probability; significant achievement scores and favorable attitude results were found in several evaluative series with college students. Because information maps are composed of separable labelled information blocks, they can serve as the data base for computer systems where both learning and reference needs must be met. Preliminary work with simulated computer displays explored the flexibility with which a system so organized can respond with a range of user options and display variations. Cost for instruction hour is competitive with that of other methods, but the method has additional advantages in its versatility and ease of updating.

TABLE OF CONTENTS

CHAPTER 1 INTRODUCTION TO INFORMATION MAPPING

OVERVIEW OF THIS REPORT

Introduction	Information mapping is the name given to a method of organizing and displaying information for learning and reference purposes. This report describes the research and development work that has been done with the method in preparing self-instructional books. It also discusses exploratory work with simulated displays for computer-assisted instruction. This report is itself written in a modified information map form.
This Chapter	We describe what information mapping is, how it began, and how it was derived from learning research, educational technology, and other fields of knowledge.
The Next Chapter	The process of writing information map books is explained and illustrated with sample pages. Some content characteristics of a set of information-mapped materials are reported.
The Central Chapters	In several evaluative studies, college students learned from information-mapped books under different conditions. We report the results here.
Later Chapters	We will: • show how information mapping may be used in computerized systems for training and reference, • report some exploratory tryouts with the simulated computer displays, • describe some cost estimates for the preparation of information-mapped materials, • summarize the present status of information mapping.

OBJECTIVES OF INFORMATION MAPPING

Introduction

In the past twenty years, we have seen a significant increase in research projects concerned with the man-information interface. The reasons for this scarcely need repeating. We have more information to handle in almost every job and discipline. This information is increasingly complex. People switch jobs more often, thus requiring more and speedier retraining. Technology changes; men must learn to use the new. The information-generating capabilities of the computer have surpassed all predictions.

Researchers are following many lines of inquiry in an attempt to augment the ability of human beings to interact with their new information environment. Hardware and software extend in many new and more flexible directions. Retrieval specialists are seeking new ways of indexing, abstracting, sorting, storing, and retrieving information. Computer-driven display units are becoming widely available. Time-sharing is enabling communities of workers to share the same data base. Psychologists and training specialists have given much more attention in recent years to the practical problems of how human beings learn. Enormous efforts are under way to refine programmed instruction and computer-aided instruction in a larger attempt to produce an "instructional technology."

Basic Aims

As one response to the burgeoning educational demands, information mapping has emerged as a system of organizing data bases for self-instructional and reference purposes. Research and development on information mapping have been concerned with these objectives:

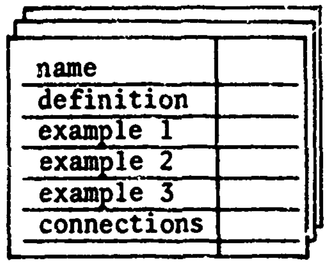
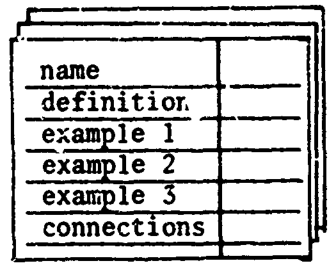
- to make learning and reference work easier and quicker
- to make the preparation of learning and reference materials easier and quicker
- to develop economical procedures for designing and maintaining (e.g. updating) training and reference materials

INFORMATION MAPPING: ITS SCOPE

Basic Concept	Information mapping is a system of principles for identifying, categorizing, and interrelating the information required for learning-reference purposes. The system can be applied to production of books for self-instruction or to the specification of data bases for computer-aided instruction. Most of the research and development work described in this report was concerned with information-mapped books.
Books	Information map books are learning and reference materials in which categories of information are consistently ordered on the page and are clearly identified by marginal labels. The arrangement of information blocks is dictated not only by logical analysis and classification of subject-matter concepts but also by analysis of the contingencies required for successful learning and reference use. Therefore, in addition to basic content material, information map books also have: · introductory, overview and summary sequences · diagrams, charts, trees · feedback questions and answers in close proximity to material to be learned · self-tests and review questions · tables of contents, alphabetic indexes and local indexes with connections to related topics

Computer Data Base	Through our studies with a book version of an information mapped subject, it has become clear that similar techniques could effectively organize a data base for computer-assisted instruction.
	
	The data base would be composed of separable labeled blocks of information together with their interconnections. This would afford a flexibility in using only those parts of the system that are required for a particular purpose.
	
	The flexible block-identified data base could be rearranged for:
	
	· initial learning
	    · for the naive student
	    · for the sophisticated student
	· relearning or review
	· reference use

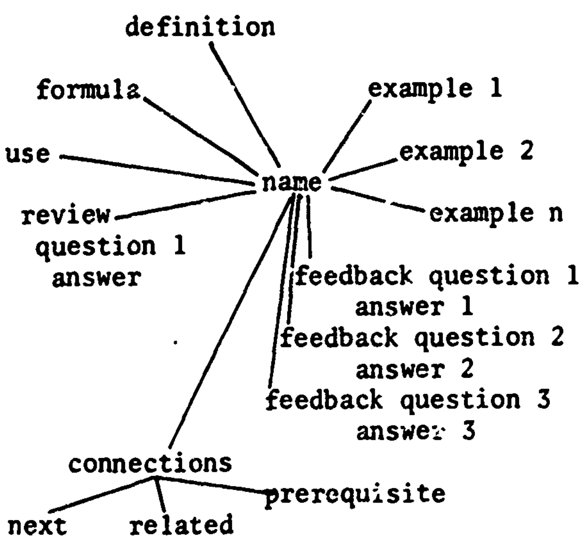
IN A BOOK FORM, INFORMATION MAPS ARE. . .

Stored this way. . .	. . .and displayed this way. . .
. . .on printed pages 	. . .on the same pages 

BUT WHEN USED IN A COMPUTER, THE SAME INFORMATION MAPS. . .

. . .are stored this way. . .

. . .in interconnected networks of electronically coded information blocks. . .



. . .and may be displayed in any of the following ways. . .

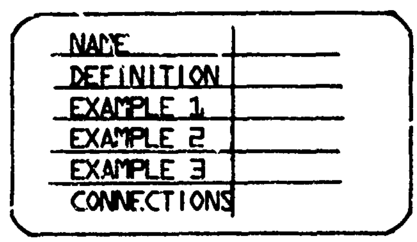
. . .as programmed instruction-like sequences. . .

NAME
DEFINITION
EXAMPLE 1
FEEDBACK QUESTION 1

FEEDBACK QUESTION 1

ANSWER 1

. . .or as information map reference. . .



. . .and in several other ways depending upon learner control and dynamic display capabilities.

VISIBLE AND INVISIBLE FEATURES OF INFORMATION MAP BOOKS

Introduction	Information maps for self-instructional books are conspicuous for their physical features, the format in which they present information. An equally important aspect of such information maps, however, is that the content itself is selected and organized according to a set of underlying principles. The method of presentation and the organization of content may be thought of as the visible and invisible features of a mapped page.
Visible Features	The more obvious visible characteristics are these: • information is presented in blocks • marginal labels identify the kind of information in each block • a consistent format is used for each kind of information: procedures follow one format, concept maps follow another distinct format, and so on • functional and uniform headings and subheadings are used to make scanning easy and to speed up reference work • each information map begins on a new page and, in programs for initial learning, most maps occupy single pages • feedback questions and answers are located in close proximity to the relevant information maps • a local index at the bottom of maps provides page numbers for quick location of prerequisite topics (The last two features are not used in technical reports.)
Invisible Features	The arrangement and sequencing of materials presented in information map formats are the result of: • detailed specification of learning and reference objectives in behavioral terms • specification of prerequisites for the subject-matter area

continued on next page

VISIBLE AND INVISIBLE FEATURES OF INFORMATION MAP BOOKS, continued

(continued) Invisible Features	• classification of the subject matter into component types (concepts, procedures, etc.) • definition of the contingencies required for successful learning and reference

ORIGINS OF INFORMATION MAP FEATURES

Introduction	In the effort to design more efficient materials for learning and reference, we drew upon accumulated knowledge in science and technology. Research findings, generalizations, and procedures from many areas were considered with a view to their possible practical value for instruction or reference.
Fields Drawn Upon	Gradually we evolved the set of guidelines and rules for organizing and displaying information that we now refer to as information mapping. These guidelines have their origins in such areas as these: · logical analyses of subject matters · learning research findings · teaching practice · programmed instruction techniques · display technology · human factors research · communications techniques, including effective writing principles The implications of the various ideas were translated into practical form and were documented as rules or procedures for preparing information maps. Example: A common research finding is that learning is enhanced when practice exercises and answers are given in close proximity to new material. This finding becomes the basis for the information map rule that a page of feedback questions and answers should generally be inserted after each map of new information.
Coming Up	In the next few pages, we draw upon the field of education to illustrate how certain information map features were derived. We also outline briefly the process of designing and developing learning materials in book form. The next chapter traces the actual process of writing maps from the present set of guidelines.

INFORMATION MAP FEATURES DERIVED FROM LEARNING RESEARCH AND TEACHING PRACTICE

Introduction

Although information map features have their origins in several fields, there is no doubt that their principal foundations lie in education and learning research. On the chart below, we indicate briefly some of the findings that led to the design of certain information map features. This chart (which is not intended to be exhaustive) is one example of the research support behind information mapping.

Naturally, the evidence is not all of equal strength, but we have tried to bring to bear on a practical task some of the most promising factors.

Because the experimental basis for some map features is extensive, we cite wherever possible research review articles to put the reader in touch with the main sources of evidence. In the citations below, such major review articles are marked by asterisks to distinguish them from reports of original research.

These results of educational research lead to . . .	. . . these implications for the design of instructional materials.
Active responding generally aids learning. (Lumsdaine and May*, 1965; Briggs*, 1968; Glaser*, 1965) The act of writing responses helps some learners. (Edling*, 1968) Feedback or knowledge of results (or 'reinforcement') often facilitates learning by: · confirming or correcting learner's understanding · providing a motivational effect · improving scanning behavior (Lumsdaine and May*, 1965; Smith , 1964; Gagné and Rohwer*, 1969; Glaser*, 1965)	Insert feedback questions after introducing new materials. Locate answers conveniently nearby.

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INFORMATION MAP FEATURES DERIVED FROM LEARNING RESEARCH AND TEACHING PRACTICE, continued

These results of educational research lead to . . .	. . . these implications for the design of instructional materials.
The insertion of questions, "test-like events," after text segments has a positive effect on learning. Giving knowledge of results further increases the effect. (Gagné and Rohwer*, 1969; McKeachie*, 1963) Self-tests, pretests facilitate retention. (Glaser*, 1965; Briggs*, 1968; Bloom*, 1963)	Use feedback questions after maps with new information and use sets of review questions after natural clusters of maps and at the end of topic treatments. Provide answers as well.
In concept learning, a variety of examples promotes learning. (Gagné and Rohwer*, 1969; Lumsdaine*, 1963)	Use examples and nonexamples to point up differences and similarities among concepts.
Instructions are useful in calling learner's attention to important features. (Gagné and Rohwer*, 1969; Gagné, 1965)	Use introductory paragraphs or previews to alert learner to importance of upcoming ideas.
Judicious use of underlining often helps to focus attention on key elements. (Hershberger and Terry, 1963)	Underline important words in definitions.

continued on next page

INFORMATION MAP FEATURES DERIVED FROM LEARNING RESEARCH AND TEACHING PRACTICE, continued

These results of educational research lead to . . .	. . . these implications for the design of instructional materials.
"Cueing" or labelling appears to aid by alerting learner to nature of upcoming information and informing him what his learning task is. (Glaser*, 1965)	Use marginal labels and informative map titles.
Pictorial materials often help learning. (Briggs*, 1968)	Use diagrams and drawings to illustrate concepts and procedures.
For some kinds of materials, charts of the information are valuable. (Feldman, 1965)	Use tables and verbal matrices to display concept relations.
Simple sentence structures in the active voice make learning easier. (Gagné and Rohwer*, 1969; Coleman, 1965)	In general, use active voice and simple sentences.

ORGANIZATION AND INTEGRATION OF INFORMATION IMPORTANT FOR LEARNING

Introduction	Some important features of information mapping owe their origins to a topic of current theoretical interest among learning psychologists - namely, the logical and psychological structures of knowledge and their impact on learning and retention.
Theoretical Discussions	Piaget had long ago speculated that "learning . . . is facilitated by presenting materials in a fashion amenable to organization" (Flavell, 1963), but it is only in recent years that psychologists have actively taken up the problems of how cognitive structures develop and of the role of organization in learning and retention. The 'atomistic' approach of most programmed instruction materials has been criticized (Stafford and Combs, 1967) and a firm case made for the advantages of "meaningful organization and holistic presentation of materials." In a symposium on "Education and the Structure of Knowledge" (Phi Delta Kappa, 1964), P.H. Phenix remarked: "It is difficult to imagine how any effective learning could take place without regard for the inherent patterns of what is to be learned." David Ausubel (1960, 1963, 1964, 1968) has developed a logical and psychological case for believing that learning and long-term retention are facilitated by 'organizers' which provide an 'ideational scaffolding.' He has now amassed considerable experimental support for his hypotheses. The well-known studies of Katona (1940) with college students pointed up the importance of organization for learning and for retention. The relation of organization of materials to ease of learning also finds support in the area of verbal learning research (Underwood*, 1966).
Implications for Information Map Books	Although many issues remain to be settled by research, a strong case can be supported both logically and empirically for the advantages of organizing and integrating features in materials for learning. Both verbal and graphical means can be used to inject a sense of organization and direction into a subject-matter presentation. In the practical effort to design effective learning materials, we have incorporated a number of features intended to help the learner integrate and organize the ideas for more efficient storage in memory. These are listed on the next page.

FEATURES TO AID IN ORGANIZATION AND INTEGRATION

Introduction

The following list of features designed to promote integration of concepts and relationships contains some that we have already adopted on other grounds. For instance, the guidelines called for practice questions and answers throughout the text because learning research suggested their value in several ways; but questions can also be phrased to encourage integration of ideas over sections of learning materials.

Examples of maps showing some of these features are given in Chapter 2.

List of Features

- reviews and previews: to take stock of the ideas developed up to that point and to prepare the ground for relating them to new concepts about to be encountered
- introductions to each map: to relate new idea to previous concepts or to familiarize with nature and importance of new idea
- recaps or capsules: to summarize succinctly the essential ideas of rules or principles in nutshell form
- tree diagrams: to sketch the ideas and procedures of a topic so as to show the role of each and its links to others
- compare-and-contrast tables: to point up the similarities and differences between two concepts that are sometimes confused
- summary tables: to chart in easy reference form the main concepts of an area
- review tests after short sets of maps and at the end of units: to promote the integration of several concepts and to practice using them in problem solving
- prerequisite charts: to show schematically the paths the learner can take through a subject matter in order to reach the learning objectives

INFORMATION MAP FEATURES FOR EASE OF REFERENCE

Introduction

In designing book-type materials for initial learning, we added features to facilitate the return to ideas previously encountered, an activity that is often frustrating with conventional texts where the contents of the paragraphs are unlabelled. Common sense, human factors research, and graphic technology were used in formulating aids for easy access to the learning materials. A list of these aids appears below.

It is clear also that these same features would be important for reference manuals or job aids. If information map materials were designed for those purposes alone, some of the introductions, explanations, and examples needed for initial learning would be omitted.

Again we note that some of the features needed for easy reference purposes have already been mentioned as desirable on other grounds. For example, labels on information blocks aid in quick retrieval of ideas but they also serve to alert the learner to the nature of his learning task and prepare him to take in a specific kind of information.

List of Features

- Tables of contents for learning books are organized and formatted to speed location of topics and special features. (This report does not use the standard format but follows certain ESD report requirements.)
- A predictable format for each type of map (concept, procedure, etc.) facilitates location of needed information.
- Map headings in consistent typography help in scanning for page topic.
- Marginal labels help not only in locating the kinds of information sought but also in skipping those not required.
- Local indexes at foot of each map permit quick location of concepts relevant to the given map.
- Decision tables display the choices appropriate for each possible situation.
- Summary tables assemble main facts and relations for easy review and reference.

continued on next page

INFORMATION MAP FEATURES FOR EASE OF REFERENCE, continued

(continued) List of Features	• Capsules provide "kernel" statements of key rules or concepts • Flow charts show graphically the sequences of events in a process • Indexes aid information retrieval.

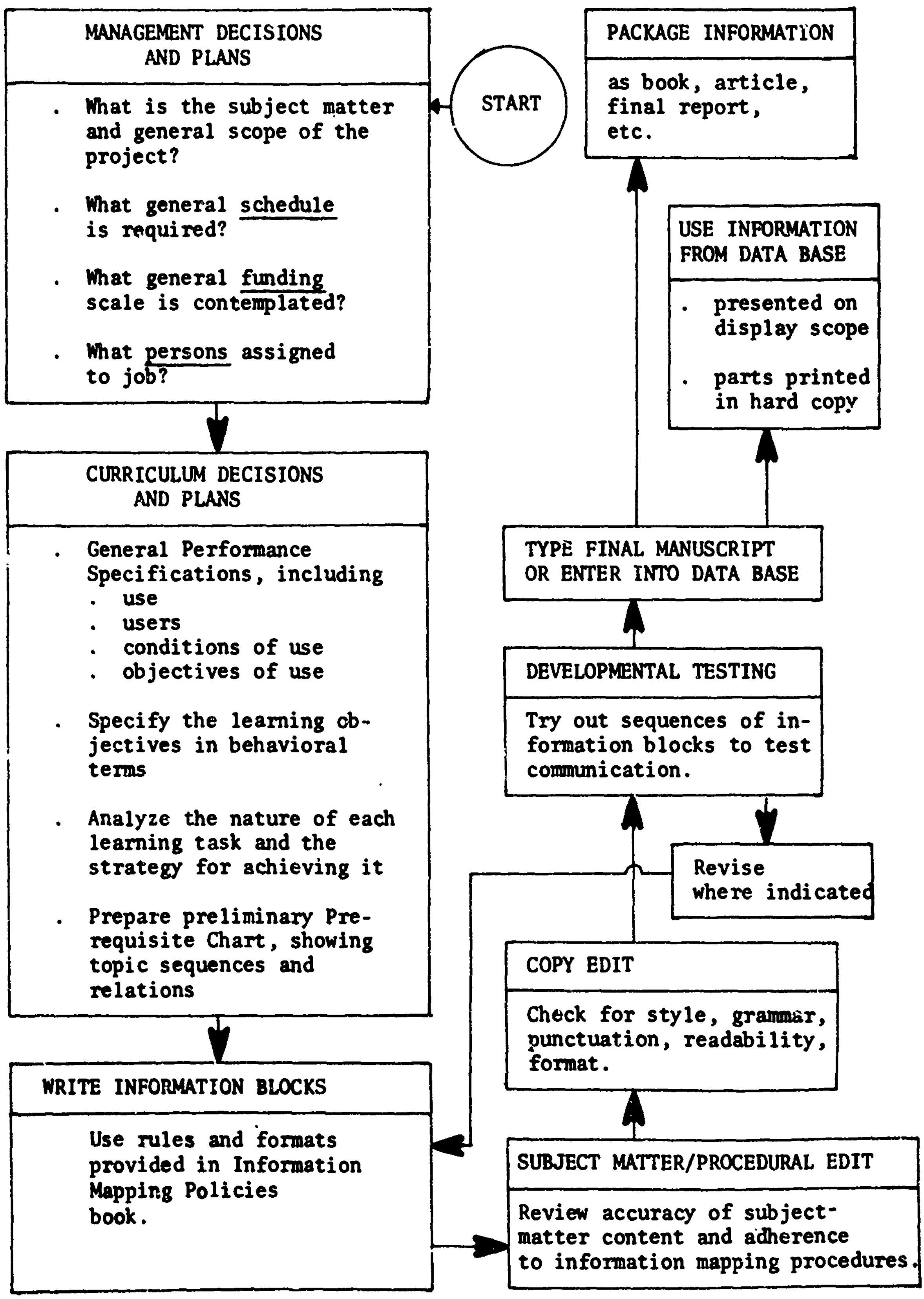
OTHER PARTS OF THE INFORMATION MAP SYSTEM

Introduction	So far we have been concerned with what information maps look like, how they got that way, and how they are written. But the process of writing cannot begin until fundamental curriculum plans are worked out. Furthermore, the end of the writing task is by no means the end of the production process -- a crucial part of that process is the series of try-and-revise cycles through which the product is refined and the learning outcomes are brought closer to the program objectives. The information mapping system, then, includes guidelines for curriculum planning and for developmental testing.
Curriculum Planning	Once the subject-matter area of the project has been agreed upon, a series of interrelated decisions must be settled, including the type of audience for which the program is intended, the conditions under which it is to be used and so forth. When the scope of the program has thus been defined, charts showing the nature of the writing task are evolved through the following steps: • The nature of the subject matter is explored and the potential topics are listed. • The learning objectives for the specific program are determined and are stated in behavioral terms. • The topics that are required to meet the specified learning objectives are organized into a schematic display called the "preliminary prerequisite chart" -- a chart working backward from the objectives to the topics that are required to meet those objectives. • Analyze the nature of the learning tasks and plan the teaching strategies for achieving them. • Revise the prerequisite chart to show the assembling of concepts into the networks of associations building toward the final instructional goals.
The Prerequisite Chart	This chart of the topics and their sequencing plus special learning materials serves as a guide to the writer in his task. The process of writing is illustrated in Chapter 2.

continued on next page

Successive Approximations	Because teaching and writing are both arts, we do not expect the first draft of a learning program to be totally successful. We rely heavily on the iterative process -- cycles of tryouts with students and revisions of the materials in response to their reactions. The most important aspect of these tryouts is that the feedback questions and sets of review questions spaced throughout the program give us immediate evidence of the topics that need amendment or expansion. Developmental tryouts and revisions are key tools in the production of effective information-mapped materials.

THE PROCESS OF INFORMATION MAP PRODUCTION



THE CONTINUING EVOLUTION OF THE INFORMATION MAP SYSTEM

Introduction

We have mentioned how the guidelines and processes of the information map system first came to be formulated. But the initial statements were only the beginning of a development process that continues into the present.

Developmental Testing

The rules and guidelines were tried out in the preparation of learning materials in several subject-matter areas. As these products took shape, they were subjected to tryout-and-revise cycles with college-age subjects. The students' responses to feedback questions throughout a given map series gave us a basis for continuing improvement of the learning units. But more important in the early stages was the value the responses had for refining the system itself. Rules were amended, format policies were changed, new procedures were introduced. The system continues to evolve gradually as our experience grows and as new situations are encountered.

Subject-Matter Experience

So far we have applied the system mainly to topics in mathematics. The major part of our experience was gained in writing, testing, and reviewing a 150 page introduction to sets and probability. This book of mapped learning materials constitutes a ten hour self-instructional course; it served as the main research vehicle for the studies reported in Chapters 3 to 7.

It was also an important influence on the development of the system itself. Maps from this work are shown in Chapter 2 to illustrate the writing process and to show the nature of the learning materials.

Other subject areas with which the system has been tried are:

SUBJECT MATTER	APPROX. NO. OF INFOMAPS
Computer programming	75
The binary number system	60
Convrs, an experimental computer language	150
Canard, a simulation language	150
Introduction to descriptive statistics	75
Introduction to matrix algebra	35
Permutations, combinations, and the binomial theorem	50

continued on next page

(continued) Subject-Matter Experience	A wider range of topics was explored by a group of graduate students in a summer school course in 1967. They prepared brief units on: • basic concepts of operant conditioning • some topics in American history • a variety of educational research concepts and procedures • two dentistry topics: how to extract a tooth, and periodontology • a topic in chemistry: the structure of the atom • the Munsel color system in art • darkroom procedure in photography • several topics in mathematics
Comment	Experience with other subject areas will undoubtedly raise new classification and display problems for which guidelines will have to be devised. But we expect that the main impetus to the evolution of the system will come from continuing research.

CHAPTER 2 WRITING INFORMATION MAP BOOKS

Introduction

To show how the rules and policies guide the writing of information maps and to give the reader some experience with actual learning materials, we describe in this chapter some major types of maps and illustrate them with sample pages. These are taken mainly from the book on sets and probability that we used in the research to be reported in later chapters.

Not all of the various types of information maps can be illustrated by this subject matter. For example, there would be no need in this material to use a <u>process</u> map, one that shows a structure changing over time.

Map Classification Chart

A full listing of the present classifications of map types with the kinds of information blocks that may appear on each is presented in the appendix. Because information mapping is a growing, changing system, we do not regard these lists as being fixed or complete. It is probable that deeper explorations into quite different subject-matter areas would reveal the need for other map types.

The Guidelines

This chapter describes the current state of the guidelines for writing some of the common types of information maps. Many of these are necessarily general in phrasing. And obviously, no matter how specific they might become, they can never eliminate the need for competent writers. Many of the more important maps (such as reviews, previews, and summaries) require a certain degree of "artistry" in order to be properly effective.

The task of working up interesting examples and feedback questions is especially burdensome and demanding because information map books use so many of these. The skill with which this task is done makes all the difference between an amusing, challenging book and a dull, boring one.

This Chapter

In our descriptions on the following pages, we assume that decisions have already been made about the major curriculum issues: the scope of the project, the nature of the intended audience and specification of the desired learning outcomes. In this chapter we illustrate the nature of the writing task from that point on.

The chapter ends with an account of some of the content characteristics of a completed set of information maps.

continued on next page

Note on the Unit Map

The sample pages presented in this chapter are maps that take up only single 8 1/2 x 11 inch pages. This arises from the fact that the authors made a conscious effort to limit each map to the single page. There were certain practical and psychological advantages in this "modular" approach. However, in certain cases of difficult topics or long procedures, it occasionally became necessary to depart from that format. In such instances, the map might take up two pages; we have no cases requiring more than two. A map always begins on a new page.

PREPARING THE PREREQUISITE CHART

Introduction

An important tool in specifying the topics that you want to present to your audience is the prerequisite chart. This serves to clarify the relationships inherent in the subject matter and the teaching strategy to be used. Prerequisite charts are not entirely new on the instructional scene, being occasionally used in curriculum planning. (The term prerequisite must not be taken to mean the prerequisite skills a student should have mastered before taking up a certain course of study.)

Definition

A prerequisite chart is a graphical presentation of the topics that will be covered in the information map book. It is called a prerequisite chart because in the network format the relation of each concept to others is immediately visible - for any given concept one can identify the topics that are prerequisite for it. It is intended to reflect not only the relationships within the subject matter but also the teaching strategy to be used in presenting the topics. (An example is shown on page 26.)

Preliminary Step

The first step in writing an information map book is to list all the topics that might reasonably be included in a course on this subject at the appropriate level. The point to keep in mind is that the topics listed should not cover the entire breadth of knowledge contained in the subject, but only those topics that are appropriate for the intended user population. This list is subject to revision as developmental testing proceeds.

Example

Our unit on sets was written for college students in the behavioral sciences, and was intended to serve as background material for a unit on elementary probability. The topics we thought should be included were:

- concept of a set
- elements of a set
- describing sets
- Venn diagrams
- subsets
- the number of subsets in a set
- null set
- universal set
- complement
- union
- intersection
- difference

continued on next page

(continued) Example

- disjoint sets
- finite and infinite sets

Since the purpose of the unit was to give those aspects of set theory that would be helpful in presenting the elementary theory of probability to students with a minimal background in mathematics, we decided to omit the distinction between finite and infinite sets (our treatment of probability was only to cover finite sample spaces).

Planning the Sequence

Because the topics in the list are obviously interrelated, the order in which they are presented must be planned. This is where the prerequisite chart helps.

Two things must be kept in mind when ordering the topics. First, there is usually no one logical sequence inherent in a subject matter. Thus, it is up to the authors to decide upon the logical sequence of the steps. This would usually involve the philosophy and "esthetic sense" of the authors about the subject matter.

The second point is that the sequence of presentation involves a "teaching strategy." The logical order chosen in the initial charting of the subject matter may not be ideal from a teaching point of view. And so the prerequisite chart will be adjusted according to the authors' perception of the learners' needs and of the most effective means of serving them. The plan may still undergo considerable change after developmental testing.

Comment

The aim of this preliminary analysis is to get the topics down to single page map size. For example, "operations with sets" is a topic that must be broken down further since we could not cover all operations in a single map for students at the intended level. Again, developmental testing will indicate where topics need to be extended over two or more maps.

The graphical presentation of the prerequisite chart is also helpful in delegating writing tasks, since presence of nearly discrete clusters in the subject matter will be quite evident and can be taken into account when assigning the tasks.

IDENTIFYING THE NEED FOR SPECIAL MATERIALS FOR LEARNING AND REFERENCE

Introduction In addition to subject-matter topics, additional materials to aid learning and review are needed at many points. Some of the information map forms that serve these purposes are: procedures, compare-and-contrast maps, tables, reviews, previews, summaries, and the presentation of certain important relations that follow logically from previous pages but which cannot be left to the students to discover.

The guidelines for writing can only indicate in a general way the kinds of places where these should be added. Many of them will be added after developmental testing has indicated some unanticipated difficulties.

MAP TYPE	DESCRIPTION	EXAMPLE
Procedure	Procedure maps explain a sequence of steps which must be followed in order to obtain a desired output.	A procedure map would be used to explain how to compute the standard deviation of a set of numbers.
Compare-and-Contrast Table	A compare-and-contrast table is used to show the relationship among certain concepts that naturally group together. It serves to remove confusion and create finer discrimination for the learner.	In set theory, a compare-and-contrast table would probably be useful for "union and intersection" and for "difference and complement."
Review, Preview, and Summary	These maps are presented before or after a group of maps that form a natural or arbitrary unit. They review what has been given thus far, showing how it fits together, and how it is related to what will follow. Since the best format for these maps will vary with the type of information that has preceded, no one guideline for these maps will be presented but different examples will be given.	One "natural" place to review and preview what is to come in the set unit is after the elementary language of set theory and before the maps on set operations. Another summary would be in order after the entire unit.

continued on next page

IDENTIFYING THE NEED FOR SPECIAL MATERIALS FOR LEARNING AND REFERENCE, continued

MAP TYPE	DESCRIPTION	EXAMPLE
Review Questions	In addition to review pages summarizing the ideas presented up to that point, we also insert at frequent intervals sets of questions requiring the learner to integrate previous ideas and to practice using them in problem solving. They are also provided . the end of units.	After maps on set union and intersection was a natural place to insert a set of review questions requiring the student to practice identification in various examples.
Implication	Some maps present information that is implied by previous material but which cannot be left to the student to discover. Theorems in mathematics certainly fall into this category, but developmental testing may point to the need for even simpler implications to be spelled out.	The theorem stating that a set with N elements has 2^N subsets would be presented on a separate map. However, we also found that some students have difficulty forming unions of different types of sets. Thus we added a map called "Forming Unions from Sets with Different Memberships."

Comment

As a result of analyzing learning contingencies, certain of these special maps will be added to the prerequisite chart before the writer begins his task.

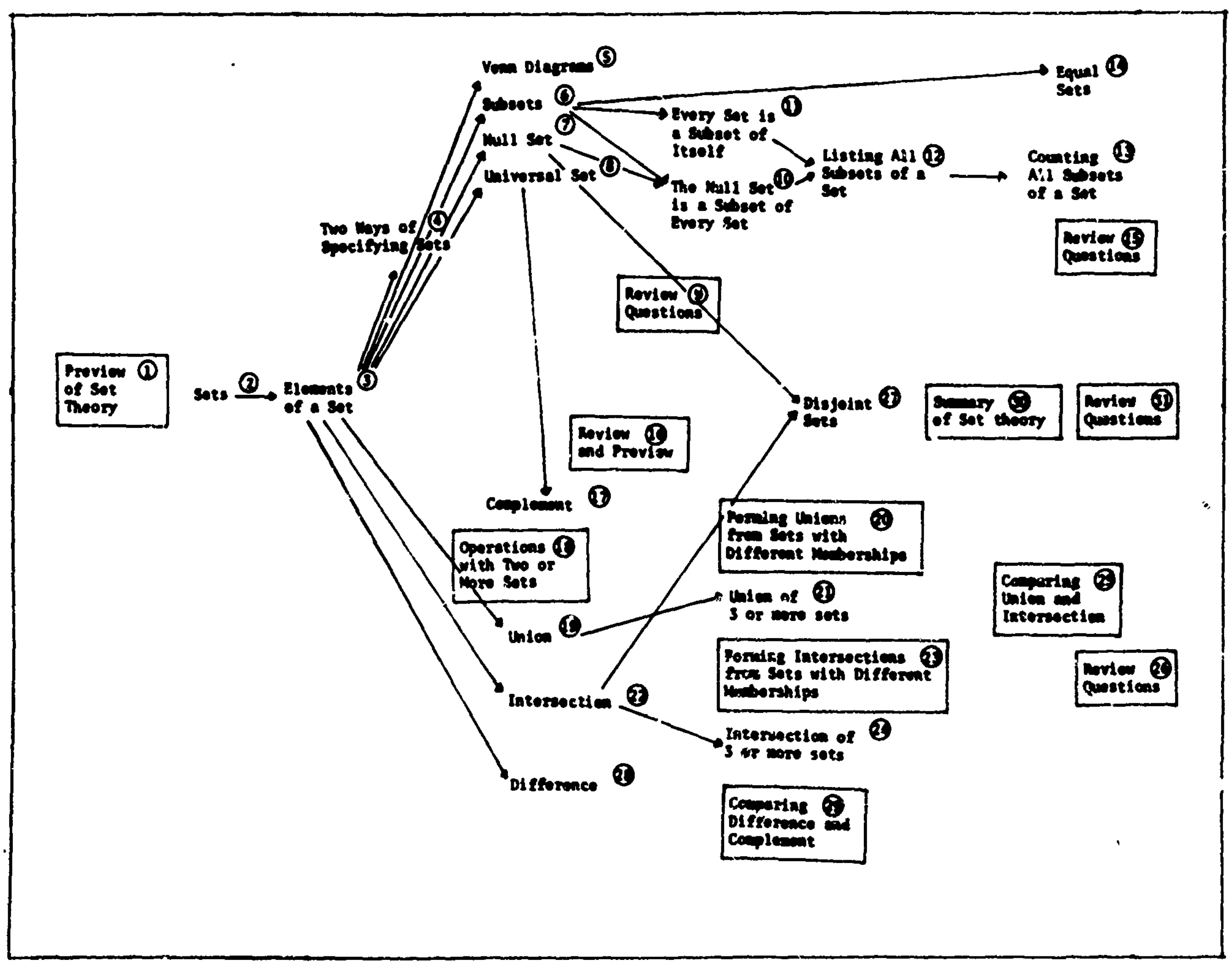
EXAMPLE OF A PREREQUISITE CHART

Introduction

Before writing begins, the complete prerequisite chart (including the special learning materials) is drawn up. This chart functions as a road map for the writer, showing him the nature of his task and the character of the terrain that lies ahead. But the chart is not only important as a guide to the writer - it can also give the learner a clear idea of his learning task and of the direction the map presentations are heading. Therefore, prerequisite charts are included in information map books.

Example

The arrows are used to indicate the logical structure of the subject matter, i.e., the relationships among the concepts. The numbers refer to the teaching strategy or t' sequence in which the topics are presented. The specia' ;arning and reference maps are shown in boxes.



WRITING CONCEPT MAPS

Introduction	After preparing the prerequisite chart, we are ready to allocate writing tasks and begin writing. The most frequently used type of map is the concept map. This page describes the format rules for this map type and the guidelines for writing some of the information blocks that can appear in a concept map (a fuller listing of permissible blocks is given in the appendix). The details on this page may be easier to follow if the reader refers to the example on page 30.
Definition	Concept maps are used to introduce new terms or topics, and to present any information that may be regarded as a statement, concept, or definition.
Format	Each concept map starts with a title that may be a term or a sentence. The title is usually the designation in the prerequisite chart. The information explaining a concept can be sorted into various types, such as introductory remarks, definitions, diagrams, notation, etc. On a concept map, each type of information is blocked off separately and labelled in the margin. These marginal labels facilitate initial learning as well as scanning and reference. A student who prefers to see examples before definitions can do so easily. The labels used most often are explained below, but when nonstandard labels would be more informative, they may be used.
Introduction Block	An introduction appears with most concept maps in order to link the new concept to those that came before or to familiarize the learner with aspects of the new idea. If present, an introduction is <u>always</u> the first information block on a concept map.
Definition Block	The definition block obviously defines the concept being introduced. If the concept is not a new term, but an implication from previous material, the definition block may not be necessary. The term being defined is always underlined. A definition may be introduced anywhere on a concept map since in some cases it might be more beneficial (from a teaching viewpoint) after an example or two.
Notation Block	If appropriate, a notation block presents any notation commonly used for the term being defined. It follows immediately after the definition block.

continued on next page

Theorem or Generalization Block

This block is usually present on a map that does not introduce a new term. A generalization block may be used if the authors do not consider the statement to be important enough to merit the word "theorem."

Formula Block

A formula may be used to restate a definition, theorem, or generalization.

All formulas are first written in symbols and then in words directly underneath the symbols. For example, the formula expressing the definition of the mean of a sample is written as:

$$\bar{X} = \frac{\Sigma X_i}{n}$$

$$\text{mean of the X's} = \frac{\text{sum of the X's}}{\text{the number of X's in the sample}}$$

The formula block follows immediately after the definition, theorem, or generalization to which it refers.

Diagram Block

Wherever appropriate, a diagram illustrating either a definition or generalization is presented. The diagram follows immediately after the formula or notation block.

Example Block

A number of example blocks, labelled sequentially, can be presented at any point on the map. The number of examples depends on the difficulty of the concept being explained. Examples may need to be added after developmental testing; this is easy since each block is a separate unit. Diagrams should be used freely within the example blocks.

Non-example Block

In some cases, a new concept may cause confusion with something the learner already knows. A non-example may anticipate the difficulty and help to clarify it. For example, students often confuse the null set with the set containing the number zero as its only element. Thus, on the map introducing the null set, a non-example block was used to make clear this distinction.

Comment Block

A comment block may be used to present any additional information that might be helpful, but which cannot be sorted into another category.

Related Pages Block

A local index listing those topics needed to understand the present concept (along with their pages) is presented at the bottom of the page.

continued on next page

(continued) Related Pages Block	Thus, if a student is having difficulty with a concept, the related pages may help him isolate the difficulty and clear it up by re-studying a previous topic. Only those topics directly connected with the concept being introduced should be mentioned; otherwise, the list would be prohibitively long.

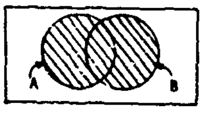
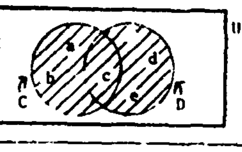
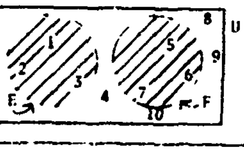
EXAMPLE OF A CONCEPT MAP

Introduction The following map introduced the concept of "Union" in the sets unit.

Example

30

UNION

Introduction	Some sets are composed of all of the elements of two or more sets.
Definition	The <u>union of two sets</u>, P and Q, is the set of all elements that are members of P, or Q, or both. Remember that the union of two sets is itself a set.
Notation	The symbol for union is $\cup$. $P \cup Q$ is read "P union Q".
Diagram	The shaded part is $A \cup B$. 
Example One	Set A consists of the numbers 7, 8, and 9. Set B consists of the numbers 4, 5, and 6. We can form new sets which contain all of the members of A and all of the members of B, and all of the members which are in both A and B., i.e. A B = {4, 5, 6, 7, 8, 9}.
Example Two	C = { a, b, c } D = { c, d, e } $C \cup D$ = { a, b, c, d, e } The shaded portion is set $C \cup D$: 
Example Three	Set E consists of the numbers 1, 2, and 3. Set F consists of the numbers 5, 6, 7. $E \cup F$ = { 1, 2, 3, 5, 6, 7, } The shaded portion is set $E \cup F$: 

Related Pages   elements, 6   set, 4   Venn diagram, 10

WRITING FEEDBACK QUESTIONS

Introduction

An information map book has feedback questions after each map, but treats them as being optional for the learner. Thus, the student can choose whether he needs the feedback or not.

Definition

Feedback questions are based on the concept of the previous page and require a minimum amount of integration with previous topics. The purpose of feedback questions is to let the student find out whether he has understood the concept presented.

Format

Feedback questions are placed after almost every concept map (as well as after certain other types of maps). They are omitted only when the term introduced on a map is too simple to warrant any practice. This is, of course, a matter of judgment; developmental testing may point to the need for additional feedback questions.

Answers are given with as much explanation as seems feasible. In our research program, the answers were placed at the bottom of the page. The students' reactions to this were mixed: about half liked the idea of not having to look up answers in the back of the book, but the other half thought having the answers at the bottom of the page was too much of a "temptation" - they tended to peek at the answer before trying to solve the problem completely.

The type of questions varied: some were true-false, some were multiple choice, and some required constructed responses. In general, the types of questions written were those judged appropriate for the learning task.

EXAMPLE OF FEEDBACK QUESTIONS

Introduction These feedback questions were placed immediately after the concept map on union.

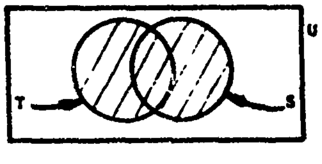
Example

FEEDBACK QUESTIONS

[Union]

1. $G = \{10, 15, 20\}$
   $H = \{30, 40, 50\}$
   $G \cup H = \{\underline{\hspace{4cm}}\}$.

2. $J = \{a, b\}$
   $K = \{c, d\}$
   $L = J \cup K$
   $L = \{\underline{\hspace{4cm}}\}$.

3. 

   The shaded portion is written ______ .

4. A = {All 4th grade students}
   B = {All girl students}
   $A \cup B = \{\underline{\hspace{6cm}}\}$.

5. The union of A and $\bar{A}$, $A \cup \bar{A}$, is (always/sometimes/never) the universal set.

ANSWERS: 1] {10, 15, 20, 30, 40, 50}. 2] {a, b, c, d}. 3] $S \cup T$. 4] {All 4th grade students and all other girl students}. 5] Always (draw a Venn Diagram).

WRITING PROCEDURE MAPS

Introduction	Some subject matters, especially in technical areas, have many procedures that must be followed in order to obtain a certain result. A formula in mathematics is a procedure since certain steps must be followed in order to obtain the result (e.g., the area of a triangle).
Definition	A procedure map presents the sequence of steps to be followed in order to obtain the desired result.
Format	A procedure map is always titled "How to..." and is divided in half vertically. The left side gives a general description of the procedure and the right side of the page follows through with an example. A box at the head of the page states what is given on the left and the example on the right. The procedure is followed step by step on the left and the example is worked out on the right.

EXAMPLE OF A PROCEDURE MAP

Introduction

This map shows the general case and the worked example side by side.

Example

HOW TO COMPUTE THE STANDARD DEVIATION

G I V E N	A set of n numbers $X_1, X_2, \ldots, X_n$	EXAMPLE. Find the standard deviation of the following test scores: 86,82,68,93,77,58,89,95,81,71
STEP	PROCEDURE	EXAMPLE
1	Add the given numbers to get the sum: ΣX_i	The sum of the ten test scores is $\Sigma X_i = 86+82+\cdots+71 = 800$
2	Square the sum and then divide by the number of cases to get: $(\Sigma X_i)^2/n$	$(\Sigma X_i)^2/n = (800)^2/10 = 640000/10 = 64000$
3	Add the squares of the given numbers to form ΣX_i^2	The sum of the squares of the test scores is $\Sigma X_i^2 = 86^2+82^2+\cdots+71^2 = 65234$
4	Subtract the result of Step 2 from the result of Step 3: $\Sigma X_i^2 - (\Sigma X_i)^2/n$	$\Sigma X_i^2 - (\Sigma X_i)^2/n = 65234 - 64000 = 1234$
5	Divide the result of Step 4 by the number of cases minus one to get: $S^2 = \frac{\Sigma X_i^2 - (\Sigma X_i)^2/n}{n-1}$	$S^2 = \frac{1234}{9} = 137.1111$
6	The standard deviation is the square root of the result of Step 5: $S = \sqrt{S^2}$	$S = \sqrt{137.1111} = 11.71$

WRITING THE SUPPLEMENTARY MAPS FOR LEARNING AND REFERENCE

Introduction	As we saw earlier, a number of maps give supplementary information to help the learner form finer discriminations, avoid possible confusions, integrate several concepts, or review previous ideas. They can also be previews to prepare him for the next learning sequences. No new information is presented on such maps.
Compare-and-Contrast Tables	A compare-and-contrast table displays two concepts, side by side, with their definitions, notation, and appropriate diagrams in order to show the student exactly where the similarities and differences lie. A compare-and-contrast table is always titled "Comparing -- and --" where the concepts being compared are inserted in the spaces. The page is divided in half vertically with the rest of the page organized as in an ordinary concept map. Usually, the definition, notation, and diagram blocks for the concepts are presented along with examples.
Reviews, Previews, and Summaries	The format for maps of this type is flexible. Certain parts of the subject matter may be suited to a summary table, while a more descriptive presentation may be better for other parts. The prerequisite chart itself serves similar functions of keeping the student oriented and aware of the direction the subject matter is heading. These maps are probably easier to write after all the others have been done. The prerequisite chart will show certain places where they will be appropriate. However, the need for more of these maps may be identified from the results of developmental testing.
Review Questions	Review questions are presented after a number of interrelated topics have been introduced - frequently before a review and preview page or after a summary map. The types of questions were similar to those in feedback questions. They are designed to help the student integrate the concepts or procedures that have gone before and to give him practice in working with the ideas. Answers are given along with as much explanation as seems needed. Page numbers are included to help locate the original topic treatment. (Since review questions closely resemble feedback questions, we do not give a sample page here.)

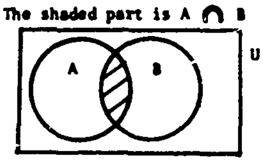
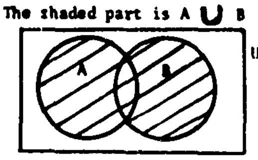
EXAMPLE OF A COMPARE-AND-CONTRAST TABLE

Introduction

We found that the distinction between the concepts of union and intersection was frequently missed by beginning students of set theory. Thus, the following page was written.

Example

40

COMPARING...	INTERSECTION AND...	UNION
Symbol	$\cap$	$\cup$
Definition	The intersection of two sets P and Q is the set of all members belonging to both P and Q.	The union of two sets P and Q is the set of all elements that are members of P or Q or both.
Venn Diagram	The shaded part is A $\cap$ B 	The shaded part is A $\cup$ B 
Example One	M = { 5, 9, 15, 33 } N = { 3, 5, 7, 9 } Notice this intersection, M $\cap$ N = { 5, 9 }	M = { 5, 9, 15, 33 } N = { 3, 5, 7, 9 } Notice this union, M $\cup$ N = { 3, 5, 7, 9, 15, 33 }
Example Two	E = { 1, 2, 3 } F = { 4, 5, 6 } Notice this intersection, E $\cap$ F = $\emptyset$ (There are no common elements)	E = { 1, 2, 3 } F = { 4, 5, 6 } Notice this union, E $\cup$ F = { 1, 2, 3, 4, 5, 6 }

Related Pages: elements, 4; union, 30; intersection, 35; set, 4

EXAMPLE OF A REVIEW AND PREVIEW MAP

Introduction

The following map was inserted after the elementary terms of set theory were introduced. It served as a quick capsule summary of all the concepts presented up to that point and gave a short rationale for introducing the operations with sets that were to come later.

Example

26

REVIEW AND PREVIEW

Past

In learning a new subject it often helps to pause and retrace the ideas covered. In doing this we can get a clearer picture of how the ideas fit together.

In set theory we have now acquired some basic notions about the nature of sets:

First we talked about what sets are and how to indicate them:

- . a set is any collection of things or symbols; it is commonly designated by a capital letter;
- . the things in a set are called elements, and the symbol ϵ shows that an item belongs to a set;
- . to specify what elements are to be included in a set, we have two methods:
  1. the roster method in which we list the elements of the set within braces, and
  2. the rule method in which we give a description or a definition that covers all the elements we intend to include.

Next the different kinds of sets were defined:

- . the universal set, called U, which is the set of all units or things under consideration;
- . the null set, which is a set with no members and which we refer to by writing $\emptyset$ or { };
- . the subset, a set than can be formed from any combination of one or more elements from another set, including
  - . all the elements in the set, so we say "every set is a subset of itself," and
  - . no elements in the set, so we say "the null set is a subset of every set."

Finally, we learned that to determine the number of possible subsets in a set, we can:

- . list all the possibilities and count them, or
- . use the formula, 2^N, which is more convenient when the number of elements (N) in the set is large.

Present

Now that we know the basic kinds of sets, we are ready to start building with them. Many kinds of problems will require that we combine sets in different ways to form new sets.

Future

The operations that can be performed to make new sets from old sets will be explained on the following pages. They are rather similar to familiar arithmetic operations with numbers.

EXAMPLE OF A SUMMARY MAP

Introduction

This table seemed to tie up the topics related to conditional probability. Readers who are not familiar with the subject matter can nevertheless note several important features of the example. The introduction underlines the importance of the topic and suggests to the student the nature of his learning task. In the left column simple questions are paired with concrete examples to help the student remember the distinctions. Formulas are as usual accompanied by verbal descriptions.

Example

134

POSTVIEW OF CONDITIONAL PROBABILITY

Introduction

Conditional probability is one of the most useful tools in probability theory. We have seen how the equation can be rearranged to give the multiplication theorem and the independence definition, both important concepts.

The inter-relatedness of these ideas is a great boon to memory. If the conditional probability definition is thoroughly understood and stored in memory, it can serve as the key to unlock recollection of how the other formulas can be derived.

For review, we re-state the definition of conditional probability along with the concepts derived from it.

QUESTION	CONCEPT AND FORMULA
What is the probability of A, <u>given</u> that B has occurred? [Given a red-haired person, what is the probability that he has blue eyes?]	<u>Conditional Probability</u>: $P(A\|B) = \frac{P(A \cap B)}{P(B)}$ the conditional probability of A, given B = the probability that both events will occur divided by the probability of B
What is the probability that both A <u>and</u> B will occur? [What are the chances of winning Olympic medals in both track and swimming?]	<u>Multiplication Theorem</u>: $P(A \cap B) = P(B) \cdot P(A\|B)$ the probability that <u>both</u> events occur = the probability of B times the probability of A, given B
Are the events A and B <u>independent</u>? [Is the event "flunking math" independent of the event "flunking history?"]	<u>Independence Definition</u>: Two events are independent if and only if: $P(A \cap B) = P(A) \cdot P(B)$ the probability that both events occur = the product of the separate probabilities.
Given two independent events A and B, what is the probability that <u>both</u> of them occur? [If Tom and I both roll a die, what is the probability that we both get sixes?]	<u>Multiplication Rule for Independent Events</u>: [This is the independence equation just above.]

CONTENT CHARACTERISTICS OF A SET OF INFORMATION MAPS

Introduction

The fact that subject-matter sentences are sorted into specified categories and are presented in labelled information blocks permits us to describe the contents of our learning materials with more precision than is usually possible.

We can count the number of definitions, examples, concepts, procedures, diagrams, and so on. We can also compute such things as the ratio of the number of new information pages to the number of old or redundant information pages.

The ability to make such descriptive statements opens up some interesting research possibilities.

The Structure of an Information Map Book

The information map book on sets and probability that was used in the research of Chapter 6 was analyzed in terms of the number of information blocks of various kinds. The results are given in this table:

Map Type	Number of Maps		
	Sets	Prob.	Total
Concept Maps			
a. For new terms	17	27	44
b. For implications	2	4	6
Procedure Maps	--	4	4
Compare/Contrast Maps	2	3	5
Reviews and Previews	3	2	5
Summaries	3	5	8
Special Example pages	--	6	6
Feedback question pages	16	31	47
Review questions pages	4	8	12
Total	47	90	137

Research Possibilities

The modular format of information maps presents a unique advantage to the researcher in that it permits him to determine the frequency with which different kinds of information appear in his materials. This means that he can manipulate experimental variables in the structure of his materials and determine the effects on the learning outcomes. For example, questions about the optimal frequency of worked examples or about the relative effectiveness of placing examples before or after definitions can be more easily researched because of the ease with which the information blocks can be moved about.

continued on next page

CONTENT CHARACTERISTICS OF A SET OF INFORMATION MAPS, continued

(continued) Research Possibilities	Subject matters themselves can be classified in terms of the relative frequency of concepts or of procedures. Optimal learning conditions may turn out to be rather different for the different types of subject matters.

CHAPTER 3 INTRODUCTION TO THE EVALUATIVE STUDIES

Introduction

With the advent of any new educational product, questions of its usefulness and of its attractiveness to potential users must be dealt with. To answer such questions for information maps our approach has been primarily to seek performance data from subjects using mapped units under different circumstances and to tap subjects' reactions to the materials through questionnaires.

Background

Our approach to the evaluation problem may be summed up by saying that we consider that:

- "media comparisons" are to be avoided,
- developmental testing with tryout-and-revise cycles is a key method for producing effective programs,
- pretest-posttest differences are meaningful evidence for judging whether or not a given instructional program has achieved its objectives.

In actual practice this means that we will evaluate specific information map products against explicitly stated learning objectives.

The spuriousness of "media comparisons" which abound in the literature of programmed instruction has been frequently discussed. In 1962, for instance, Stolurow detailed his reasons for judging media comparisons inappropriate and he expressed the "prediction and firm hope . . . that the comparative study will become extinct."

In their 1965 review of the educational field, Lumsdaine and May summarize the shortcomings of media comparisons and they applaud a decrease in "futile attempts to assess the over-all value of media by comparisons with 'conventional' instruction, and a corresponding increase in the proportion of studies which attempt to manipulate specifiable variables."

Our General Approach

The evaluation program addresses itself to two issues:

1. The practical one of validating instructional sets of information maps, and

2. The more experimental one of investigating certain parameters of these sets of information maps and of determining their influences on instructional outcomes.

continued on next page

(continued) Our General Approach

Attitude of the user toward the new method is recognized as being a very important facet of the evaluation program. It matters little if a program is strikingly effective in teaching, yet repels students from further contact with the subject matter. Many educators are now turning to attitude and user-preference data as being even more informative than performance data in assessing the value of instructional techniques. In our evaluative series we use several kinds of attitude questionnaires.

We also have relied heavily on developmental testing of each instructional unit. Preliminary tests of the materials were made as a matter of course to guide us in revising and improving the text. They were also used to perfect our instruction and attitude packages for the more formal tryouts. Only one of these was systematic enough to warrant separate attention here and it is included in the description of the final series.

The Evaluative Series

The instructional materials evaluated during this project dealt with topics in mathematics: the first units were entitled Mathematics Essential for Statistics; later units were concerned with elementary probability theory. All were aimed primarily at college students in the behavioral sciences and the intention was to make the topics understandable even to students with minimal mathematical backgrounds. The materials were to be self-instructional.

It is convenient to discuss the evaluations of information maps in terms of three main testing periods. These together with a brief designation of details are given in the table below. Each study will be described in subsequent chapters.

Study Designation	Date	Topics Covered	No. of pages	Comparative Conditions
Tufts University	Sept. 1968	permutations, combinations, binomial	84	controlled laboratory study versus home study.
Harvard University	Oct. 1968	sets, permutations, combinations, binomial	126	information map version versus a derived "prose" version
Spring Series	June 1969	sets, elementary probability	151	study for a closed-book test versus study for an open-book test.

CHAPTER 4 THE TUFTS UNIVERSITY TRYOUT SERIES

Introduction

The first planned evaluative study of learning from a set of information maps took place in September, 1968. The instructional unit was entitled Mathematics Essential for Probability and it consisted of pages of maps and of feedback questions covering the topics of permutations, combinations, and the binomial theorem.

This first tryout was a simple, short-term one designed mainly to explore the effects of the information map unit when used both under controlled laboratory conditions and in a "natural" mode of use in home study.

Basic Purpose

The Tufts series was conducted to enable us to:

- estimate student achievement as a result of using the learning materials under two conditions:
  - in a supervised, timed study period,
  - in home study over a week's time;
- discover students' assessment of the Information Map as a communication technique and of its value in self-instruction;
- locate areas of the text that required adjustment;
- obtain estimates of the time required to study pages in information map form.

Subjects

The 22 students for this study were members of a course in statistics for the behavioral sciences given in the Psychology Department of Tufts University. Eight students were graduate students in sociology, ten were psychology majors, three were joint psychology-mathematics majors, and one was a mathematics major.

Typically, the class met once a week for three hours. Our tryout was carried out during the second and third meetings of the fall term; no materials duplicating the information map topics were assigned to the class before or during this period.

General Plan

The tryout of the information map was planned to consist first of a supervised study period in the students' classroom during which they would work through the book at their own pace for approximately 95 minutes. Pretests and posttests would tap the extent of their subject-matter knowledge and would record their attitude toward mathematics courses in general.

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(continued) General Plan	Following that phase of the tryout, the subjects were to take the books home, work on them during the week and return at the next class period prepared to take a final exam. In point of fact, the plan to have students study at home did not work well at all. The reasons appear to be unrelated to this project, but were rather a consequence of the fact that some students had erroneously enrolled in this course for which they were unqualified; they were therefore discouraged and demoralized during the home-study period. Ten of them actually withdrew from the course a few days later. According to their notes and comments to us, the posttest given after the intervening week was for many a retention test rather than a test of their grasp of new material. The results section will reproduce the relevant data.
Data-Collection Forms	1. Three subject-matter tests were used to measure the subject's understanding of the topics before and after studying the information map book under the laboratory situation and after a further home-study period. 2. A pre-study attitude questionnaire was designed to record the subjects' feelings about mathematics courses and about previous experiences with learning research. 3. A post-study attitude questionnaire tapped subjects' reactions to learning from the information map materials, to the presentation methods of the map book, to specific format features and toward the possibility of further study from such materials. 4. Personal information about each subject's major, year in college, previous college courses in mathematics was collected. 5. The instructions asked subjects to write criticisms and comments throughout the book whenever they wished.

Procedural Details

STEP	PROCEDURE
1.	Orientation. General explanation of the plan for the tryout and the range of material to be covered was given. Students already familiar with the topic were encouraged to leave.
2.	Attitude questionnaire. Five brief questions were completed.
3	Pretest. This was administered under conditions where each subject's time was recorded, but no more than ten minutes were permitted (nor in fact, needed).
4	Study instructions. Books were distributed and instructions were given to answer feedback questions and to write criticisms as they read. One hour and thirty-five minutes were allowed, including time for a short break as each individual desired. Students were asked not to consult with one another during the study phase.
5	Study termination. At the allotted time, work was stopped and students were asked to record the number of the page on which they were working at that time. This record was collected.
6	Post-study attitude questionnaires were filled out under timed conditions.
7	First posttest of amount learned was conducted under timed conditions similar to those of the pretest: subjects were permitted up to ten minutes for this, but if they finished earlier, the experimenters recorded the exact time.
8	Homestudy. The class was instructed to finish studying the book during the coming week and to record time spent on the log provided; they were to prepare for a further posttest a week later.
9	Second posttest was administered as before after the books and time records had been collected.
10	Books were returned to students who requested them.

Data-Analysis Methods	Because this is simple study of learning outcomes and attitudes toward this kind of instructional materials, the data analysis methods consisted of <u>t</u>-tests of the two sets of gain scores: . gain in score from the pretest to the first posttest (given during the supervised, timed study period) and . gain in score from the pretest to the second posttest (given a week later after possible home study, although in fact many students did not do any home study). Attitude data were simply summarized to indicate the strength of subjects' opinions about various features of the learning materials. Comments recorded in the books were compiled as a guide to further revisions of the material. They had a practical objective and will not be recorded here.

RESULTS

Achievement Scores

Scores on the subject-matter tests were stated in terms of the percentage of items successfully passed. These are given in the table below for the total results of this study and also for the separate topics covered in the information map material.

Posttest-1 was the test given at the end of the supervised, timed study period; posttest-2 was given a week later after the possibility of home study.

Section of Book	Pretest (N=22)	Posttest-1 (N=22)	Posttest-2 (N=19)
Factorials	68.2%	100.0%	92.1%
Permutations and Combinations	19.3%	61.3%	69.3%
Binomial Expansion	50.0%	31.8%	56.5%
TOTAL RESULTS	32.6%	72.7%	61.6%
TOTAL RESULTS WITH BINOMIAL EXCLUDED	29.1%	79.6%	65.1%

The total results line of the table represents a severe test of the learning materials; the reason for this is that when posttest-1 was given after one hour and thirty-five minutes of study, well over half of the students had not finished reading the book. Even so, the improvement is statistically significant.

A t-test of the differences in scores from pretest to posttest-1 is highly significant with a $P<.001$ ($t_d = 5.96$, $df = 21$). Posttest-2 scores, those obtained a week later, are also significantly greater than the pretest scores. They are, however, considerably smaller than those of the first posttest. A possible reason for the decreased effect may be found in the students' time logs which show that a sizable percentage (50%) of them did not study the materials during the week.

If we exclude the final topic, the binomial, which many students had not read, the results are those of the last line of the table. After studying the book for about an hour and a half, the subjects scored correctly on almost 80% of the questions on factorials, permutations and combinations.

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(continued) Achievement Scores	Whether we evaluate the total results line or the results with the binomial excluded, the gains from pretest to each of the posttests are statistically significant. The central point of the achievement score evaluation is simply that the learning materials have made a significant impact on the subjects' knowledge of the subject-matter area. The differential rate of success on the separate topics showed that more developmental work was needed in certain areas. Subjects' comments supplement this conclusion.
Time	During the timed, supervised study period in the classroom, subjects were allowed breaks if they wished to stroll about outside. The experimenters kept a record of these times and subtracted them in figuring each subject's total study time. If the total time spent with the learning materials is divided by the total number of pages the subjects covered in the period, we have a first estimate of how long it takes to read information map pages. This estimate will be somewhat atypical because here the subjects were asked to answer all the feedback questions, whereas normally they would be told to work only those where they felt the need. The total number of minutes divided by the total number of pages completed gives 1.6 minutes as the estimate of mean time for a page.

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Attitude Results

Often the most important effects of an instructional program lie in its capacity to attract and sustain students' interest. For this reason we were particularly concerned to learn our subjects' reactions to the mapped material.

Items in the attitude surveys consisted mainly in statements to which the subjects responded by encircling one of these: strongly agree, agree, undecided or neutral, disagree or strongly disagree. In a few cases a slightly different set of response terms was used.

Rather than reproduce the questions verbatim, we shall give the gist of them more tersely along with the percentage of subjects expressing given views:

1. The learning materials were rated easy or very easy by 86.4%; no one found them difficult.
2. Learning by this method was rated effective or very effective by 90%; the remaining 10% of the subjects were undecided; no one rated them ineffective.
3. As to whether the learning materials progressed too slowly, 55% said no, 36% said yes.
4. Slightly over 86% said they would recommend the materials to other students; 9% said they would not.
5. As to whether it was difficult to adjust to the new manner of presentation, 95% responded no; 5% were undecided.
6. Asked whether there were too many worked examples, 64% said no; 23% said yes.
7. The feedback questions were found effective by 86%; the remaining subjects were undecided.
8. Asked if the feedback questions were too numerous, 95% said no; 5% were undecided.
9. Just over 72% of the subjects felt they would retain material learned from information map books better than that from standard textbooks; the rest were undecided.

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(continued) Attitude Results	10. In general the few subjects who were not enthusiastic about this way of learning were those who had taken between six and ten semester courses in college mathematics. These were students who should have followed our initial request that those well versed in mathematics not participate in this tryout since it was aimed at those with a minimal background in mathematics. The instructions here were unusal in requiring subjects to work out all feedback questions; several mathematics majors reported that this was especially slow and frustrating to them.
Summary of Major Findings	1. After studying information map units on mathematics, a group of 22 college and graduate students showed a highly significant gain ($P<.001$) in achievement test scores over pre-study levels. 2. They expressed a highly favorable attitude toward the learning materials. 3. A large majority (90%) found the materials effective or very effective, while the remainder were undecided. 4. Differential scoring rates on subtopics and comments obtained from the subjects served as guidelines in further refinement of the learning materials.
Limitations of the Study	The gain scores, while highly significant, may be biased by inequalities between the pretest on the one hand and either of the two posttests on the other. Although we tried to make the tests equally difficult, no procedures were used to control for possible differences. In view of the limited objectives of the tryout, more elaborate methods and statistical analyses would not have been justified.

CHAPTER 5 THE HARVARD UNIVERSITY SERIES

THE EXPERIMENTAL PLAN

Introduction

The second formal tryout of information map materials was carried out at the Harvard Graduate School of Education with students enrolled in an introductory statistics course.

The students studied a book of our learning materials in a "natural" setting -- at home where they usually study rather than in a controlled laboratory situation. They did however take the achievement tests and attitude surveys under timed, supervised conditions in the classroom before and after a week's study period.

The learning materials for this series consisted of the same counting-methods units that the Tufts group had used and in addition there was a 42-page unit on set theory.

While the tryout was aimed primarily at learning more about students' behavior with and reactions toward information mapped materials, this study was designed also to explore the effects of certain features of the maps.

Background

The Harvard series was designed as a first step in research to investigate experimentally the influences of certain features of information maps on instructional outcomes.

An earlier chapter distinguished between certain visible and invisible characteristics of information maps. The visible features included certain obvious aspects of formatting, spatial arrangements and labelling, while the invisible features referred to those analyses and classifications of the subject-matter area that determined the content of the information map text.

It was the visible features of the maps that we chose to manipulate experimentally in the Harvard series.

The General Approach

Whatever may be the functions of these visible features, the structures that display the text materials, it is important to know whether or not they facilitate initial learning.

For this study two sets of materials were prepared:

- a set of information maps prepared in the usual manner, and
- a set of "prose" materials made by simply removing the visible, structural features, such as boxes, labels, unit pages, and by running the sentences along in standard prose paragraph form. The prose version retained the same sentences, the same feedback questions and the same learning

continued on next page

(continued) The General Approach

features. For several charts and tables, we had to write in a few extra sentences to include the semantic content conveyed by the lines or boxes.

For example, the prose version of the union map given on page 30 looked like this:

Example

UNION

Some sets are composed of all of the elements of two or more sets

The union of two sets, P and Q, is the set of all elements that are members of P, or Q, or both. Remember that the union of two sets is itself a set.

The symbol for union is $\cup$. $P \cup Q$ is read "P union Q"

The shaded part is $A \cup B$:

Set A consists of the numbers 7,8, and 9. Set B consists of the numbers 4,5, and 6. We can form new sets which contain all of the members of A and all of the members of B, and all of the members which are in both A and B. i.e., $A \cup B = \{4,5,6,7,8,9\}$

$C = \{a,b,c\}$
$D = \{c,d,e\}$
$C \cup D = \{a,b,c,d,e\}$

The shaded portion is $C \cup D$.

Set E consists of the numbers 1,2, and 3.
Set F consists of the numbers 5,6, and 7.
$E \cup F = \{1,2,3,5,6,7\}$

The shaded portion is $E \cup F$:

Related Pages	elements, 6	set, 4	Venn diagram, 10

FEEDBACK QUESTIONS

(Union)

1. $G = \{10,15,20\}$
   $H = \{30,40,50\}$
   $G \cup H = \{$ ________ $\}$

2. $J = \{a,b\}$
   $K = \{c,d\}$
   $L = J \cup K$
   $L = \{$ ________

Experimental Groups	These two sets of materials will hereafter be referred to as the IM or P versions. Each of the two versions covering sets, factorials, permutations, combinations and the binomial was produced in book form with the title Mathematics Essential for Probability. Subjects were assigned to the IM or P group at random. Otherwise the two groups were treated alike, being instructed and tested together as one group.
Basic Questions of the Study	To extend our understanding of the value of information maps, the questions we asked were: • To what degree can we measure the effect of the visible features of information maps on learning? • Do the visible features appear to contribute to user acceptance of the learning materials? • What are some of the operating characteristics of information maps when used in a "real" setting, i.e., where students use them at home?
Test Materials	A pretest and a posttest were prepared to cover the subject-matter objectives; because class time available for such testing was severely limited, the tests had to be shorter than we would have liked. For the same reason, the pre-study attitude survey contained only 5 items to tap students' reactions to their previous mathematics courses. A 16-item post-study attitude questionnaire was used to register the subjects' opinions about the form and content of the learning materials. Each subject was also asked to provide supplementary information about their college and high-school mathematics backgrounds, their field of specialization, and any teaching or tutoring experience.
Subjects	The subjects were all graduate students in the School of Education, Harvard University, who were enrolled in a course entitled Introductory Course in Educational Statistics. They had backgrounds ranging from recent college graduates to teachers to administrators of large universities on sabbatical.

EXPERIMENTAL PROCEDURE

Introduction

The idea of the experiment was presented to the class at their first regular meeting of the semester; none of the topics covered in our experimental books were discussed in class or in homework assignments during the period of the experiment.

Procedural Details

STEP	PROCEDURE
1	Orientation. On September 25, 1968, we made a brief announcement to the class and distributed handouts explaining that we were trying out some new learning materials, that we sought volunteers, and how the try-out schedule was planned. Students were assured that in no way could this project affect their course grade.
2	Instructions. On September 30 the class was stopped 15 minutes early to enable us to carry out the pretesting of those students who wanted to volunteer for the study. Of the 66 students present, 52 volunteered. They were given brief instructions about the general plan and then were given both written and verbal instructions about the tests of Steps 3 and 4.
3	Pre-Attitude Questionnaire. 2 minutes were allowed (and were sufficient) for answering the 5 questions.
4	Pretest. Each subject took a ten-minute pretest on the subject matter.
5	Random Assignment Process. While Steps 3 and 4 were being carried out, the names of the students were entered on a previously prepared list of random numbers and an appropriate copy of the learning materials, either IM or P, was labelled with each student's name. These were distributed at the end of the test phase.
6	Study Instructions. Students were told that we were testing two versions of the materials and that we asked that they not discuss them with one another nor inspect the other version until after the experiment. The subjects were asked to study the material at home, to record the amount of time and the number of pages involved in each session, and to write criticisms and comments freely on the text pages. The personal data record form was to be filled out as well.

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EXPERIMENTAL PROCEDURE, continued

(continued) Procedural Details

STEP	PROCEDURE
7.	Post-study Attitude Questionnaire. On October 7, 1968, in the last 15 minutes of the regular class period, we began the posttesting with the 16-item questionnaire which required about three minutes. The learning materials were collected.
8.	Posttest. The ten-minute posttest was given to 41 subjects.
9.	Followup. Since 5 of the IM group and 4 of the P group were not present for posttests, several steps were taken to determine whether these dropouts differed from other students. Five of the 9 responded to requests for further information. We were unable to detect any differences between the dropouts and the complete subjects.
10.	Choice of IM or P versions. Since we had to retain the study copies of the books with their very useful comments and criticism, we invited the students who wanted their own personal copy of the materials to pick them up at our offices. This gave us the opportunity to inquire into user preferences through planned interviews.

METHODS OF ANALYSIS

Introduction

The primary question we were interested in was whether the two versions of the book were associated with differences in gains from pretest to posttest scores. While it is common in such cases to evaluate the differences in gain scores between the two groups, we chose to use the more precise method of analysis of covariance.

Analysis of Covariance

There is always the possibility that in spite of the random method of subject assignment, the two groups might differ in entering knowledge of the subject matter. To guard against this, we carried out the analysis of covariance using the pretest score as covariate.

In effect what this accomplishes is to adjust the posttest scores so that the effects of any initial difference in pretest scores between the groups is eliminated. (Details of the method and rationale may be found in Snedecor and Cochran, 1967.)

Other Analyses

We were of course also interested in determining for the total subject sample whether learning gains were significant regardless of the book version studied. An ordinary _t_-test for paired comparisons was used for this.

In addition we shall present brief summaries of the following classes of data:

- the amount of time spent in studying the materials,
- attitude scores of the subjects,
- mathematical backgrounds of the groups,
- subjects' preferences as revealed in choices of IM or P versions for their personal libraries,
- comments on the books and on learning experiences with them.

It will be recalled that a major point of the study was to obtain detailed criticism of the books; thus for our own use, we compiled the subjects' comments as a guide to identifying points of common concern. Some of the kinds of changes suggested will be mentioned.

RESULTS

Achievement Scores

The IM group contained 20 subjects and the P group 21. For both groups the gain scores from pretest to posttest were statistically significant. The mean pre- and posttest scores are shown in the following table.

Group	No. of Subjects	Pretest Mean Score	Posttest Mean Score	Adjusted Posttest Mean Score
IM	20	9.50	19.10	19.56
P	21	11.52	18.10	17.65

Our primary interest lies in the comparison of learning effects for the two groups. The analysis of covariance, it will be recalled, afforded a method of adjusting the posttest means for differences in the initial proficiency of the two groups. Those adjusted means are shown in the final column of the table above.

Although the IM posttest mean is larger than that of the P group, the difference has no statistical significance, the $\underline{t}$ of the difference being only 1.17 (38 d.f., $P<.2$).

The complete details of the analysis of covariance are provided at the end of this chapter.

Time Data

Students were asked to keep a time sheet on how they used the materials. It included the following categories:

Study Period Number	Day	Time Begun	Time Ended	Pages	How did you use the material? Comments...

18 of the IM group and 20 of the P group gave us this information. It was tabulated to provide answers to several questions about the use of the books:

How many of these finished the book?

- 75% of the IM group finished or got within the last 5 pages of finishing (these were pages that contained no new information).

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(continued) Time Data

. 47.6% of the P group finished or got within the last 5 pages of finishing.

How long did the subjects study?
Based on those subjects who finished or got within the last 5 pages:

. the IM group spent an average of 5.21 hours (N = 15)
. the P group spent an average of 3.87 hours (N = 10)

The subjects' times were highly variable and the difference between the two groups was not statistically significant ($\underline{t}$ = .644, 23 d.f , P <.5).

There was, however, a significant difference between the mean pretest scores for the two groups of complete subjects:

	IM	P
Pretest Mean	8.73	14.00
No. of Subjects	15	10

$\underline{t}$ = 2.22 (P <.05, 23 d.f.)

This may indicate that the P group knew more of the subject-matter than the IM group and so went through the learning materials more quickly.

USER PREFERENCE DATA

Introduction

We invited the participants to pick up their own personal copy of the materials at our offices after the experiment was over (Information Resources, Inc. offices are 3 1/2 blocks from the Graduate School of Education, Harvard).

The record of their choices provides an interesting indication of their reactions toward the two books and some insight into their thinking about learning materials.

When they came, they were given the two versions, IM and P, and asked to examine them and decide which one they wanted. They were not permitted to take both. The interviewers insisted gently that they really had to examine both versions before choosing.

In one instance, the interviewer refused to accept the choice of an IM version by a person who said "Oh, I'll take this one because I haven't used this kind." The interviewer insisted that the person have a reason based on a preference for one or the other kind of materials.

We also interviewed the subjects about
. the experiment
. the learning materials
. their learning habits

The interviews lasted between 5 and 45 minutes and averaged about 1/2 hour.

Data on User Preference

Twelve students came to our office; 11 chose the IM version.

Here is the tabulation:

		Version Chosen: IM	Version Chosen: P
Version Used	IM	6	1
	P	5	0

Interview Data	Our subjects made these comments after they had examined both IM and P versions in response to the question, "Why did you pick this version?"
Picked IM	"The format in boxes is more tidy. I like it better. It's easier to read." "The relationships are implied. Things are parallel. If you have things related, you can go through the material much faster. This book is organized better than an ordinary text. I liked the examples. You knew not only what it was, but what it wasn't. You could see the same example in different settings. You could see just how inclusive an example could be. People were amazed to see how complicated statistics was in our text compared to how simple it seemed here. Our author can't write clearly." "This is the one I really want. I'll get more involved in it... The layout is better for me. I can always grasp it better when it's in blocks." "Oh, I prefer the boxed-in one. I'll choose it." "The text in our course goes much too fast for me. 15 pages to cover what you cover in 105. But yours went faster than our text because it was easier. I didn't have to make up the steps in between." "I especially liked learning how to learn from your materials. By the way, I noticed that the blocked version had a value of telling me just how much I had learned... it also gave me a clear stopping place. I could feel comfortable at stopping at the bottom of the page." "The boxes really appeal to me. I like having things categorized in that fashion. When I was using the other book (P) I felt that I was getting it. However, when I took the posttest I realized that I hadn't. I'd like to go through the box version. I think I might be able to get more out of it. In class, we did the perms. and combs. the next week. Those students who didn't participate in the experiment were lost. The rest of us found it easy."

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(continued) Picked IM	"It's compressed and the organization is better. A mathematical format. Yeh! That's the way to do it. Maybe this [P] is organized just as well, but flow charts are much better. The trouble with most texts and this book [P] is that they're so damn verbal. You should arrange things in a matrix form -- it's so logical, so mathematical -- it makes more sense in mathematics to present things in this form."
	"I am the ex-president of a college. One of the interesting things about your book was that I was initially turned off because some of the pages resembled 'organization charts'! And I have unfavorable associations with organization charts. But I decided to try the material anyway. My attitude changed abruptly to a favorable one, because I began to have confidence in the material. There were places where the materials broke down, that is, they didn't teach me what I wanted to know, but I still felt confident that I could go on and figure it out. You never get this feeling from an ordinary textbook."
Picked P	"I don't think that they are useful...those tree-type things. There seems to be more verbiage cut out of this one[P]. I think I'll take it. There's a psychological factor, I guess....It looks easier to get through."

SUPPLEMENTARY RESULTS

Attitude Results

1. 45% of the IM group and 68% of the P group rated the materials easy or very easy.

2. Learning by this method was rated effective or very effective by 80% of the IM and 73% of the P group; the rest were undecided.

3. 11% of the IM and 31% of the P group thought the material progressed too slowly, while 79% of IM and 47% of P disagreed with this statement.

4. 90% of IM and 94% of P groups said they would recommend the material to another student; the rest were undecided.

5. When asked whether the presentation was hard to adjust to, 85% of the IM group and 80% of the P group said no. Curiously enough, 5% of the IM group and 10% of the P group said yes.

6. Asked whether there were too many examples, 85% of IM said no (the rest undecided) but only 55% of P said no, 22% said yes and the other 23% were undecided.

7. 95% of IM thought feedback questions were effective (the rest undecided) while 84% of P thought they were effective and 5% thought they weren't.

8. Asked if there were too many feedback questions, 85% of IM said no (rest undecided), 83% of P said no, and 17% of P said yes.

9. 40% of IM and 57% of P group thought they would retain material learned this way better than by a standard text (the rest were undecided).

10. 70% of IM and 84% of P would like to use similar learning material for other topics in the course (only 1 student in each group disagreed, the rest were undecided).

SUPPLEMENTARY RESULTS, continued

Other Findings	. An analysis of the personal background information of each subject showed that the two groups were comparable in terms of sex, high school and college mathematics courses taken, undergraduate degree patterns, teaching experience, and attitude towards mathematics in general. . Male subjects judged the learning materials more favorably than their female counterparts in both groups.
Limitations of the Data	No special measures were taken to control for possible differences in pre- and posttests. Biases here could influence the magnitude of the gain scores which for both groups of subjects were highly significant.

DISCUSSION

Interpretation of the Findings

The lack of a significant difference between the gain scores of the two groups suggests one or more of the following:

- The visible features of IM's may not contribute so much to initial learning as do the content analysis or feedback provisions.

- The experimental procedure, constrained by the time restrictions dictated by use of this formal class, was not sensitive enough for demonstrating any differences that may exist between the two versions.

The latter possibility seems especially reasonable to us. The visible features of IM might be expected to operate primarily to alert one to the nature of the incoming information and to facilitate scanning for new material or for review. In a one-time read-through of a short text, perhaps one should not expect effects of the visible features to emerge very strongly. Rather it is in situations requiring information retrieval and integration where their advantages might show up. A different set of tasks in a less time-bound testing situation should be more sensitive to such effects.

Students found the visible features useful and appealing. The time data as well as the interview and choice data support this generalization.

- Students also singled out specific pages for favorable unsolicited remarks. These types of pages drew such remarks: feedback questions, compare-and-contrast pages, tables, overviews, summary pages.

We obtained some solid information for revision relevant to constructing information maps for books:

- Put classification trees and prerequisite maps at the end of units rather than at the beginning (where they tended to scare more students than they helped).

- Build in self-tests instead of objectives pages at the beginnings of units.

- Increase the number of maps in some areas where students had difficulties.

NOTE ON STATISTICAL DETAILS

Analysis of Covariance

In order to compare the learning effects for the two groups, we used an analysis of covariance of the posttest scores using the pretest scores as covariate, summarized on page 57.

The results of the analysis of sums of squares and products were:

Source	d.f.	Σx^2	[illegible]	Σy^2
Total	40	1405	593	1270
Between groups	1	42	-20	9
Within groups	39	1363	613	1261
Reduction due to regression	1	-	-	275.7
Deviations from regression	38	-	-	985.3

Regression coefficient: $b = 0.45$
Deviations mean square = 25.9

The estimated standard error for the difference of two adjusted means is:

$$s_D = \sqrt{\frac{2}{20}(25.9)\left(1 + \frac{42}{1363}\right)} = 1.63$$

$$\underline{t} = \frac{19.56 - 17.65}{1.63} = 1.17 \ (38 \text{ d.f.}, P < .2)$$

CHAPTER 6 ASSESSMENT RESEARCH STUDIES, SPRING 1969

INTRODUCTION

Background

In order to obtain a set of learning materials extensive enough to serve as a serious research vehicle, we developed a unit dealing with those topics in elementary probability that are basic to an understanding of statistics.

The subject matter was approached through the concepts of set theory, which formed the first unit of the learning package. (The materials on permutations, combinations, and the binomial theorem were set aside for the time being with the intention of using them later as a unit preceding elementary statistics.)

The probability unit was developed by the usual route of try-out-and-revision cycles. When these reached the point of dwindling criticisms from learners, we designed a more formal assessment of the program's effect.

Although the set unit was included as an integral part of the package, it was not evaluated in this assessment study because it had already been evaluated in the Harvard series, and because time pressures induced us to limit the tests to the new materials.

General Objectives

The probability unit was used in an assessment study that would permit us to describe some of the effects that can be expected when the unit is used for initial learning under various conditions.

The assessment includes statistical tests of pretest-posttest gain scores.

The study was planned to reveal how subjects with different backgrounds and degrees of mathematical proficiency would interact with the learning materials under different conditions of use. We were interested in obtaining information not only about the changes in students' achievement scores, but also about their attitudes toward various features of the learning units and toward possible future study with such materials.

The design was one which would permit us to indicate the range of effects that might be expected from learners who aspired to different levels of proficiency in the subject area. And finally, we wanted to obtain information about the usefulness of the materials for reference work as opposed to use in initial learning.

CERTAIN RESEARCH ISSUES

Introduction	In planning experimental programs, we consider alternative approaches and decide upon a research strategy that we believe will yield the most informative results under the given circumstances. In the present case we will describe the reasoning behind certain decisions in the experimental plan.
The Issues	Three particular questions concerned us: 1. Objectives for studying the materials, 2. The relevance of time pressures in assessing performance, 3. Test sensitivity and the problem of a reference point. Each of these will be discussed in turn.
Learning Objectives	When we considered the variety of purposes for which one might engage in studying a particular subject matter, we realized that it is neither realistic nor helpful to potential users to phrase an objective in terms of what percentage of students will pass an examination at a given level of proficiency. A student might take up a course because he wants a general understanding of the major concepts of the area and a knowledge of where to look for details or procedures when the need arises. His way of using a program would differ from that of a student who was trying to achieve a thorough mastery of the subject in order to pass the Graduate Record Examination. It would be most helpful to know how each used the materials and how long they spent to achieve their given goal. It is clear also that in many formal courses it is the instructor who formulates the objectives -- usually without consulting the victims. Whether or not the two sets of goals agree no one seems to have inquired. Against this background we decided to try to make the validation testing more informative and relevant to realistic learning situations. In brief, our plan called for students to use the information map book under one of two sets of instructions that are designed to simulate common learning situations: • where a student uses the book in a course that requires a thorough understanding of concepts and procedures and an ability to work problems in <u>closed-book examination</u>; and

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(continued) Learning Objectives

- where the student uses the book to acquire a general knowledge of the area and enough familiarity with procedures to pass an open-book test.

It seemed to us that performance figures from these two types of test, when coupled with time data and personal information about the subject, would afford a more realistic picture of the effects of the instructional program.

In order to get a lead on the subjects' own goals, as distinguished from those we set down for them, we asked them just before the posttest to record the grade they expected to get on the test. To complement this, one of the questions on an attitude survey asked about the level of proficiency they usually aspired to in mathematics courses.

In actual use in an educational system it is quite possible that these learning materials would be used in conjunction with other methods of instruction -- with an instructor and classroom discussion, for example.

In the assessment of this program, however, we were interested primarily in the effects of the materials when used alone. This gives us the strictest test of the units and permits us to estimate the minimum effects these units are capable of producing.

The Time Factor in Proficiency Measurement

Many measures of proficiency depend upon the amount produced in a given time period and a premium is put upon producing the greatest number of responses in the shortest time. While such a rating may be desirable for assembly-line performance, it seemed to us that a time-based criterion was of limited relevance to many learning situations.

Accordingly we devised a posttest situation that permitted the students' performance to be measured both under a condition of time pressure and under a condition of a generous time allowance. The latter condition seems to be more compatible with the objective of acquiring a general facility with an area and a knowledge of where to find things when they are needed. Speed of production would not be especially important here.

In preparing for certain entrance examinations for college or graduate school, however, speed and accuracy are both sought.

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(continued) The Time Factor in Proficiency Measurement

To secure posttest performance scores relevant to situations both with and without time pressure, we used the following method:

1. During the initial test phase, a time limit of twenty minutes was imposed; subjects were asked to work as quickly as possible. They were required to write with black pens.

2. At the twenty-minute signal, green pens were substituted for the black pens and the subjects were allowed to continue another forty minutes if they liked or to turn in their papers when they were satisfied with their effort. They were free during this period to correct any black answers they wished to change.

This technique was used for both the open-book and closed-book test conditions. It was not used in the pretests because except for two or three cases the subjects knew too little about the topic to require more than the twenty-minute allotment or they knew it so well that they finished well within the twenty-minute period.

Test Sensitivity and a Reference Point

In a study such as this where the goal of assesssing the educational value of the material is combined with the goal of determining how its effects vary with certain conditions of use, the construction of achievement tests must be considered from several points of view.

In the first place, it is important to have a test that is sensitive enough to pick up differences in comparative conditions. In our study, to be able to measure the results of both open- and closed-book tests, for example, we must have a test that permits students to demonstrate the full range of their proficiency in the easier open-book situation. This means that the tests must be constructed to include difficulty levels that we do not expect our subjects to attain. It must be complex enough so that it does not set a ceiling on the scores of superior students. Thus, we are not here trying to write a "criterion-referenced" test where students are expected to pass the majority of items.

Consequently the test was designed to be difficult and beyond the expected capacity of our subjects.

But with such a test, we have the problem of how to judge the subjects' scores. We can no longer judge them by saying we expect a certain percentage of the subjects to pass a given percentage of items. In order to have a reference point

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(continued) Test Sensitivity and a Reference Point	with which to compare their scores, we devised a competence standard based on the scores that certain "experts" made on the same tests. Our "experts" consisted of 6 advanced candidates for the Ph.D. in Statistics at a local university. Four of them had completed all Ph.D. course and examination requirements; all of them had had at least one full-year course in probability and mathematical statistics. Their mean scores on the subunits afford at least a reasonable yardstick for speaking about the subjects' achievements. We shall be able to make statements of this form: after 8-10 hours study over a two-week period, X% of the subjects reached a level equal to about 70% of the experts' scores, etc.

DEVELOPMENTAL TESTING

Objectives

In order to prepare for a formal evaluation of the revised units on Sets and Probability, we used a preliminary group of 8 subjects to try out and criticize the various materials for us. These latter included not only the information map units but also the achievement tests, attitude questionnaires before and after study of the books, and instructions on use of the units.

The purposes of this tryout were to debug the learning and test materials, to obtain comments and reactions to the total package, and to gather study-time data to aid in planning the formal evaluative study.

Subjects

The 8 subjects may be classified as follows:

- 2 graduate students, Harvard School of Education
- 4 undergraduates, Harvard College
- 1 housewife who had finished 1 year of college
- 1 high school senior

In terms of the College Qualification Test N (Form A), a standard test for college freshmen, our group of subjects was high in mathematical ability: 5 of them scored above the 94% level; the scores of the remaining 3 were 74%, 60%, and 24%.

Procedure

The numerical ability test just mentioned, the pretest, an attitude questionnaire and a personal information sheet, were all filled out by the subjects in their first session. Then the two units were given to them to work on at home, keeping a time record and comments on the log provided. After approximately two weeks, the subjects returned at a time of their choice and took the posttest and further attitude questionnaires. They were also interviewed to get reactions in addition to the comments written in their study books.

Results

The achievement tests given before and after study can be broken down into separate scores for the sets and probability units:

	Mean Pretest Scores	Mean Posttest Score
Sets	67.5%	95.5%
Probability	57.1%	89.8%

The attitude data showed that these subjects reacted favorably to the materials: all thought that learning by this method was effective, no one found difficulty in adjusting to the style, 6 felt that they would retain the material better than

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(continued) Results	with a standard text (the other 2 felt there would be no difference), and 7 expressed an interest in studying other topics written in the information map style. The average time for completion of the text was 7.23 hours and the median time was 6.5 hours.
Project Decisions	As a result of these tryouts, a number of changes were made in the materials intended for the evaluative experiment: 1. First of all, the learning materials were revised to meet the comments of the subjects; the material on conditional probability was expanded because some experienced difficulty with the topic. 2. Because the various tests took up more time than we judged desirable, attempts were made to shorten them. The prerequisite test, which had required thirty-five minutes, was shortened to include only items especially relevant to probability problems -- that is, those concerned with manipulating fractions and solving algebraic expressions. The test was reduced to twenty items and a time limit of ten minutes was imposed. 3. In the achievement tests, given before and after study of the book, important changes were made. Because the students (with only one exception) had made very high marks on both pretests and posttests, we added items, made some questions more complex, and deleted easy questions passed by most subjects. This kind of change was required by our need for tests that would be sensitive to differences in conditions of the open- and closed-book tests and would set no ceiling on the showing of superior students. 4. Nondiscriminating questions in the attitude surveys were omitted and some new questions were inserted.

THE EXPERIMENTAL PLAN

Introduction	The experiment through which we wanted to study the effectiveness of the revised learning materials was designed with certain built-in controls and certain procedures for eliminating spurious influences.
Test Materials	To measure the subjects' knowledge of probability before and after reading the book, we drew up two achievement tests, which we shall call A and B. These were equal in length and as equivalent in difficulty as we could make them. Copies of the two tests are given in the appendix. To eliminate the possibility that there was in fact some difference between them, we arranged the test plan so that Test A served as pretest for half of the subjects and as posttest for the other half; similarily Test B was the pretest for half of the subjects and the posttest for the other half. This assignment was done at random. With achievement scores obtained in this way, any differences in scores made before and after reading the book could not be ascribed to the fact that one test was more difficult than the other. We mentioned in the previous section that as a result of developmental testing, these achievement tests were made more difficult. Another result was that the test of numerical ability, which we refer to as a prerequisite test, was shortened. The attitude surveys which were to tell us what the students thought of the learning materials had similarly been revised. Those students who were given an open-book test also filled out a very brief questionnaire about their use of the book during the test. Early in this chapter we mentioned that one point we were interested in was how the subjects' own goals for the course may be related to the amount of time they spent with the materials and to their achievement scores on the posttests. We tried to get an estimate of the subjects' own objectives in this way: those achievement tests that were slated to be posttests were furnished with a cover sheet on which subjects were asked to record the grade they expected to make on the test. This "level of aspiration" figure, we conjectured, would give us an estimate of the subjects' goals for the course. The last page of the test booklet asked what grade they thought they made. Each subject would also fill out a personal data sheet asking about his educational history, field of major interest, and experience in the area of mathematics.

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Experimental Design

Each subject was assigned to one of three groups:

- open-book,
- closed-book test group, and
- control group.

A brief description of each of these will be given before we take up the procedure in detail.

The Control group took the prerequisite test, filled out the personal data sheet, and then took two achievement tests in a row. They did not see the learning materials at all. The purpose in having this group was to find out how much information might have been gained from the tests themselves and to provide a standard by which the increase in score from pretest to posttest for the other groups could be judged. The achievement tests A and B were each used equally often for pretest and posttest.

The Closed group filled out the personal data sheet, pre-study attitude questionnaire, the prerequisite test, and finally the timed pretest in their first session. They were then given the material to take home to study and to record the time spent on it. An instruction sheet explained that they would be given a closed-book test when they returned. The post-study attitude survey was inserted at the end of the book and was to be filled in before the subject came back for the posttest. When subjects in this group returned, they were given a closed-book test. Approximately two weeks elapsed between pre- and posttest.

The Open group went through the same routine as the Closed group the first session. Afterwards in their instructions in the front of their books, they were informed that the learning objectives would be evaluated by an open-book final test.

The tests were in essence individually administered, although often several students would come together and would be tested in the same room. But each was given special materials, dictated by the plan, and each was timed separately.

The intention was to secure approximately twenty subjects for each group; in practice we fell slightly below that number.

The group of experts, whose scores on the achievement tests were to serve as a reference point, were given the tests under conditions similar to the control subjects. Half of them took Test A first and Test B second; the other half received the tests in the opposite order. The order for each expert was determined at random. They were not given a time limit but only two of them took longer than 20 minutes on the pretest and all took less than 20 minutes on the posttest.

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Subjects

These learning materials were intended mainly for students in the behavioral sciences who were often lacking in mathematical background but who needed to be prepared for statistics. Accordingly we sought as subjects persons primarily of college age and we imposed no requirements of previous mathematical training beyond elementary high school algebra.

Because of the time of year, however, we expected shortages of test subjects. As a result the subjects were not assigned to groups strictly at random. When a subject called about the experiment, he was assigned at random to a group and given information about the work required and the pay for that group. At times, however, a subject would consider the pay not worth the trouble of coming down for the tests (if he was in a control group), or the work required taking too much time (if he was in an experimental group). If this happened, he was told of the other possibility. The assignment of the experimental subjects to the Open and Closed group was strictly at random since there was no difference in the work required.

The 18 subjects who agreed to take part in the experiment as controls varied in age and background:

- 9 were college students (2 in social science, 2 in education, 2 in the arts, 2 in natural sciences, 1 in nursing, 1 in dental technology, and 1 uncommitted);
- 2 were college graduates who were now employed;
- 2 had 1 year of college and were looking for jobs;
- 3 were graduate students (in psychology, education, and political science)

The backgrounds of the 35 experimental subjects were:

- 20 were college students (5 in social sciences, 5 in education, 6 in the arts, 2 in biology, 1 in physics, and 1 uncommitted);
- 5 were high school graduates (2 were employed, 3 were about to enter college);

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(continued) Subjects

- 6 were college graduates who were now employed;
- 4 were graduate students (in psychology, economics, government, and art history).

The prerequisite and pretest scores for the three groups were:

	Prerequisite	Pretest
Control (N = 18)	13.22	8.44
Open (N = 17)	13.53	7.35
Closed (N = 18)	13.11	8.89

The similarity of backgrounds and initial test scores for the three groups seems to indicate that no serious bias resulted from the non-random groups assignments. If there were any differences in initial test scores the method of analysis used would control for this.

The group who served as experts were six graduate students in Statistics at a local university. Each had at least one full year graduate level course in probability and mathematical statistics. Four of the six had passed the qualifying examinations for the Ph.D. degree.

Operational Procedure

STEP	PROCEDURE
1	Recruitment. Subjects were recruited by advertising at local colleges and using acquaintances of the investigators. Subjects in the Open or Closed group were paid $?0 and Control subjects $5.
2	Randomization. Sixty-two numbers were assigned to the groups (and to each order of tests A and B within a group) at random. When a subject called, he received the next available number on the list and was assigned to the group corresponding to that number with the exception explained in the subject section.
3	Orientation. When a subject arrived, we gave him a brief account of the purpose of the experiment. (Control subjects were merely told that we were testing the effectiveness of the examinations he would be taking.)
4	Form and test administration. We gave the subjects the appropriate forms and administered the prerequisite test (10 minutes), the pretest (20 minutes) and the pre-attitude questionnaire. They were then given the learning material and asked to follow the instructions printed inside, and return for the posttest in 2 weeks at a time they arranged by phone.
5	Posttest. When the subject returned for the posttest we checked to see that his post-attitude questionnaire was complete, and then administered the posttest in two stages: during the first 20 minutes, the subject wrote with a black pen; then a green pen was substituted and he was allowed to continue up to 40 minutes more. If he finished before that (as many did), the exact time he used was recorded. If the post-attitude questionnaire had not been filled out the subject did so after the posttest. If the subject was in the Open group, he also filled out the reference attitude questionnaire.
6	Follow-up. If a subject did not arrange for the posttest in the expected interval, we called him and he came within a day or two. We were not able to locate two subjects, three returned the material for personal reasons, and four were dropped from the study because of a mistake in assignment of test forms to them.

METHODS OF ANALYSIS

Introduction

In addition to presenting descriptive results, we shall report a statistical analysis of the differences between the experimental groups and the control group using the technique of multiple analysis of covariance. The rationale for this has been described in the chapter on the Harvard series.

Description

In the Harvard study we explained how the analysis of covariance provides a method of adjusting posttest scores for differences in the initial proficiency of the groups, and we described how we used the pretest as the covariate.

In the present experiment the same considerations led us to make a similar analysis, which is generally considered preferable to t-test comparisons of simple gain scores (see Experimental and Quasi-Experimental Designs for Research, Campbell and Stanley, Rand McNally, 1963).

In the Harvard study only the pretest was available as the covariate but in the present series, we have pretests and prerequisite tests as well. Thus we were able to use both of these covariates in our analysis of the posttest scores. Such a multiple analysis of covariance is described in Snedecor and Cochran (1967).

RESULTS

Introduction

Instructional programs have many outcomes. In everday usage programs are studied for different reasons by students who differ in background knowledge, in natural aptitude, and in study habits.

Our aim was to produce learning materials that the student could proceed on in his own way with a minimum of previous experience. Our test of the program simulated two common everyday situations where the instructor imposes the objectives of a course in terms of an open or a closed book test.

In addition we recognized that students have their own goals regardless of the demands of the instructors.

The things we want to know about a program are the evidences of learning and the amount of time spent for the different proficiency goals, as well as evidences of aversive or attractive powers of the materials as revealed in the students' comments and responses to attitude probes.

Achievement Scores

The posttests yielded two scores: those obtained in the 20-minute time period and those obtained within an hour. For both of these measures the means and standard deviations are displayed in the table below for each of the three groups of subjects:

TEST	OPEN (N=17) Mean	S.D.	CLOSED (N=18) Mean	S.D.	CONTROL (N=18) Mean	S.D.
Prerequisite	13.53	4.80	13.11	4.28	13.22	4.97
Pretest	7.35	5.59	8.89	6.72	8.44	8.57
Posttest-1						
Unadjusted	17.18	8.30	17.72	9.10	9.33	7.68
Adjusted	17.62	5.72	17.41	5.72	9.24	5.72
Posttest-2						
Unadjusted	22.41	10.35	22.22	9.20	---	---

The primary analysis, the multiple analysis of covariance, was applied only to the posttest-1 scores, using the prerequisite test and pretest as covariates. This is the "strictest" assessment of the data, showing the effect that occurs under the pressure of limited test time. As a result of this analysis, the posttest-1 scores were adjusted as shown in the table above.

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(continued) Achievement Scores

When these adjusted means are compared, we find that each of the experimental groups, Open and Closed, is different from the Control group to a highly significant degree. The note at the end of this chapter gives the statistical details.

These posttest-1 results show that even with the time restrictions, the learning materials have significantly influenced the students' understanding of probability problems.

Since posttest-2 mean scores are higher than those of posttest-1, they are obviously also significantly different from the pretest scores.

For neither set of posttest scores would the Open and Closed groups be statistically different from each other. There was no apriori reason for expecting a difference.

Test Forms Compared

In the results cited above, the use of Forms A and B of the achievement tests was equalized over conditions, as the test materials section explained. Thus any differences in the two test forms could not account for the results obtained. In other analyses where we want to look into the results in relation to subjects' attitudes, backgrounds, and so on, the two test forms may not happen to be equally represented. Therefore it is interesting to inquire first whether in fact the two forms do differ.

Pooling Control, Closed and Open groups, we find the following scoring rates on the two test forms when each was used as pretest and as posttest-1, and for the two combined:

TEST	MEAN SCORES AS PRETEST	MEAN SCORES AS POSTTEST-1	OVERALL MEAN SCORE
Form A	6.73 (N=26)	17.00 (N=27)	11.96
Form B	9.70 (N=27)	12.31 (N=26)	10.98

The mean totals for the two forms are not significantly different.

Incomplete Subjects

In a number of the analyses we wish to discuss later, it will be necessary to make allowance for the fact that all subjects did not finish studying the book. The principal reason for this is that the assignment was too heavy for them to cover in a two-week period in addition to their other work. For the ninety per cent who were employed during the day, the topic of probability must not have seemed appealing leisure-time fare.

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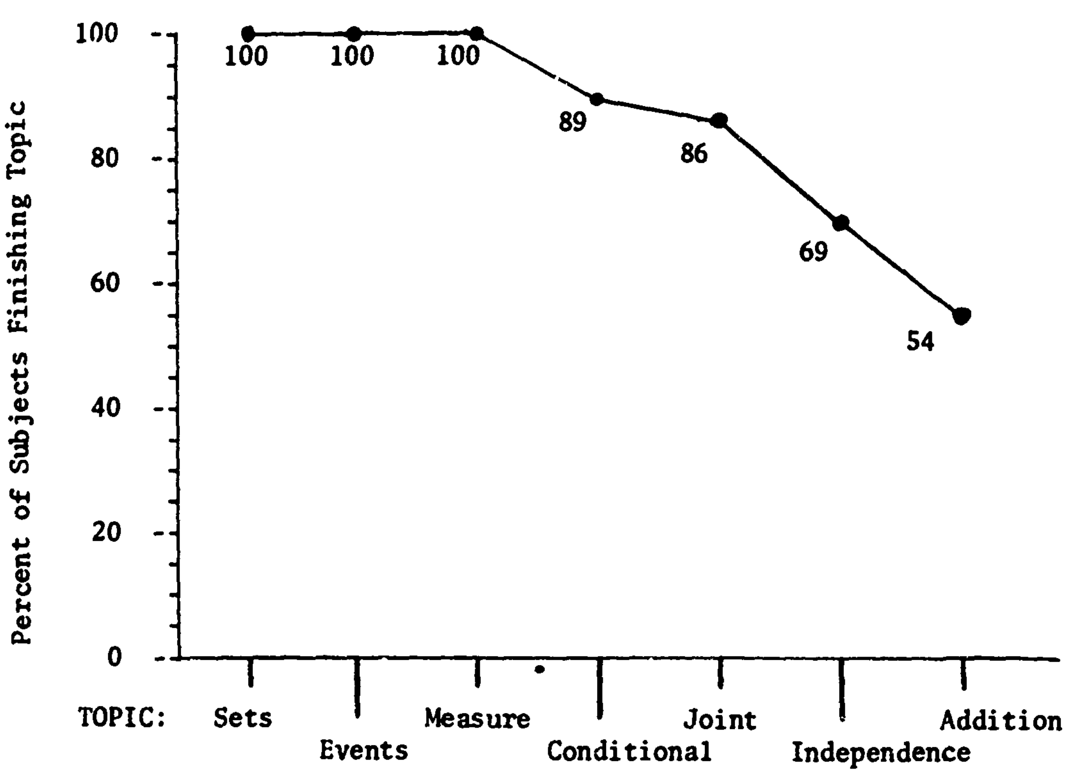
(continued) Incomplete Subjects

The amount each subject did complete was determined jointly by the time log (where the page coverage was recorded) and by the evidence of completed feedback pages.

The graph below shows the percentage of subjects who completed the various topics of the book. Beneath the graph, the topics themselves are given in order along with the number of pages involved and the cumulative page total from beginning to end of the book.



TOPIC:	Sets	Events	Measure	Conditional	Joint	Independence	Addition
No. of pages:	49	35	15	11	10	15	9
Cumulative No. of pages:	49	84	99	110	120	135	144

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(continued) Incomplete Subjects	These data will enter into an analysis we shall describe presently concerning success rates for the various topics. Since we want to compare our subjects' performance on these topics with that of the experts, we must pause first now to describe the experts' scores.
Experts' Scores	Each of the six experts who served as our comparison group took the two achievement tests, Form A and Form B; thus we have twelve scores to average for our reference point. The highest possible score on each test was 46. The mean of the experts was 40.16. The scores ranged from 32 to 46; the median was 40.5.
Subjects' Scores Compared to Experts'	In the two experimental groups, Open and Closed, 19 subjects completed studying the entire book. Four of these obtained posttest-2 scores equal to the mean of the expert group. Four more scored between 70% and 90% of the experts' mean score. Thus, 8 out of the 19 subjects obtained scores exceeding 70% of the experts' mean score. The table below gives all the results:

	Percentage of Experts' Mean Score				
	100-91	90-81	80-71	70-61	Below 61
Number of subjects scoring	4	2	2	5	6
Per cent of subjects scoring	21.1	10.5	10.5	26.3	31.6

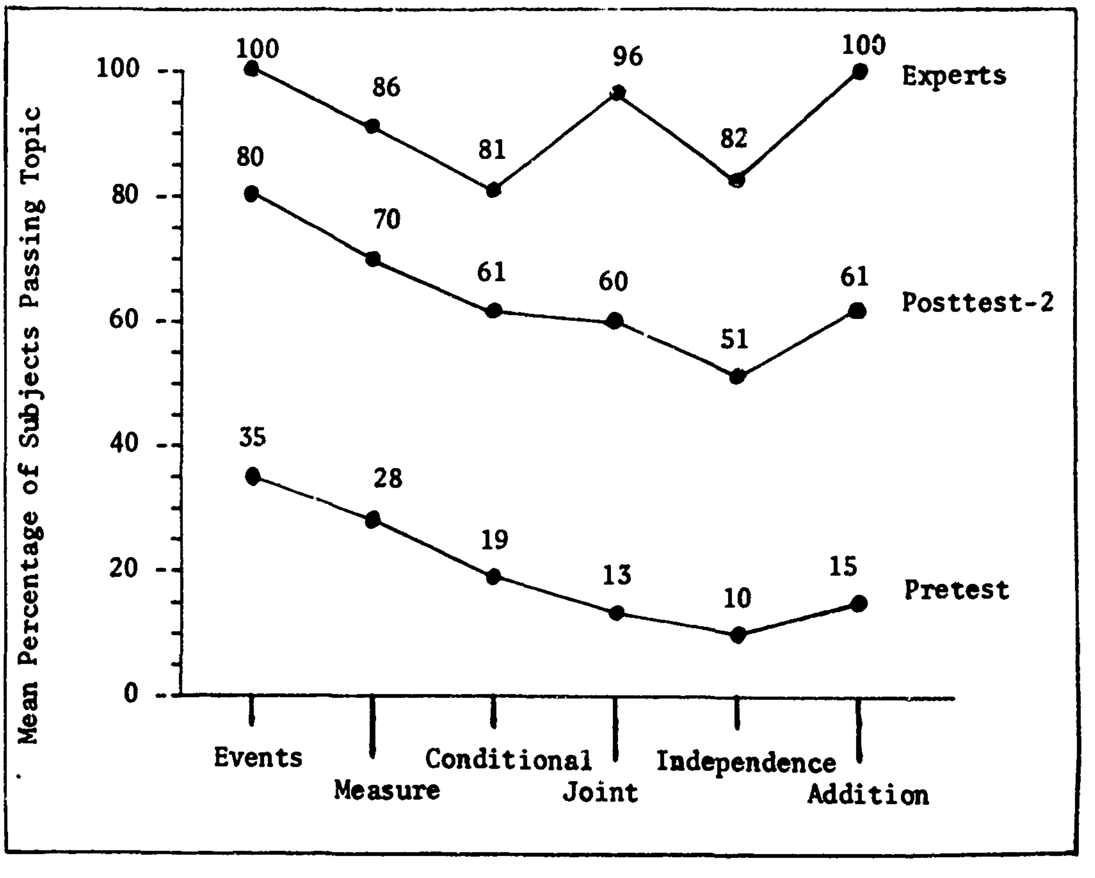
The unfinished subjects naturally did not do as well. Only 6 of the 16 exceeded 50% of the experts' mean score.

Success Rate on Separate Topics

The learning materials can easily be subdivided into separate topics and a success rate computed to see if the sections are equally effective.

Pretest and posttest-2 scores were plotted for each topic using only the data of those subjects who had comleted study of the given topic. Posttest-2 scores were used because we are more interested in over-all amount of learning apart from any skill in rapid retrieval. For this analysis of topic effectiveness, Open and Closed groups were combined since their scores were very similar.

The graph below plots the results in terms of the mean percentage of subjects passing the items for a given topic.



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(continued) Success Rate on Separate Topics

The decline in scores from left to right is interpreted as indicative of the difficulty of the topic; for example, conditional probability is more complex to grasp than is simple event terminology. The fact that the distance between pretest and posttest-2 lines is almost equal right across the graph is encouraging evidence that the topic treatment has been uniform.

The top line in the graph plots the standing of our group of experts on these various topics. For the most part they follow a trend much like that of our subjects.

Time Data

We next took up the question of whether students who are preparing for an open-book examination study as long as do students anticipating a closed-book test.

The time data were obtained from the students' logs.

Data bearing on this question are of interest to prospective users who may wonder what time investments they must make for given learning outcomes. The information is also of interest as an indication of students' reactions to the two different test prospects.

In presenting the time data for the two subject groups, we separate those who finished the book and those who did not:

SUBJECTS WHO FINISHED BOOK					
Condition	Mean Pre-requisite Score	Mean Pre-test Score	Mean Post-test-1 Score	Mean Post-test-2 Score	Mean Hours of Study
Open (N = 8)	15.63	9.27	19.88	28.00	8.08
Closed (N=11)	13.27	9.73	21.73	26.45	10.27

SUBJECTS WHO DID NOT FINISH BOOK					
Condition	Mean Pre-requisite Score	Mean Pre-test Score	Mean Post-test-1 Score	Mean Post-test-2 Score	Mean Hours of Study
Open (N = 9)	11.67	5.22	14.76	17.43	7.43
Closed (N=7)	12.87	7.58	11.44	15.73	8.28

The more informative and cleaner comparison is to be found in the data of the complete subjects. Here we see that those in the Closed group spent over two hours longer in study than did the Open group students. It is interesting to note that in posttest-2 they scored almost as high as did the Open group who had their books to consult.

In this connection the students made some spontaneous comments about their attitudes toward preparing for tests: several

continued on next page

(continued) Time Data

remarked that one must study just as much for an open-book test because otherwise it is easy to become confused and panicky leafing through a book under test pressures. At the post-test sessions, a considerable number (62%) of the Open group subjects even reported forgetting that they were to have an open-book test. Yet the group as a whole did put in less study time than did the Closed group.

The data for the unfinished subjects have several points of interest also. In the Open group the unfinished subjects studied almost as long as did those who finished, so apparently the fact that these subjects did not get finished was not from neglect of the task. If we look at their other data, we find that these Open incomplete subjects had low scores on their prerequisite test and on their pretest as well.

A rather similar picture emerges from the data of the incomplete Closed subjects -- their prerequisite test scores were not so bad but they too did poorly on the pretest for the probability unit. They studied two hours less than did the members of their group who finished the task. In a later section we shall look into the relation of test scores and the mathematical background of the students.

Briefly, then, the time data show:

- The probability and set units require about 8 hours of study for an open-book test and 10 hours of study for a closed-book test.

- Students who are not so well prepared mathematically can be expected to take longer.

Open Book Use During Test

We mentioned above that some students remarked that they did not rely on the book much during open-book tests and that some of our students even forgot that they were to get an open-book test.

Fortunately after the test we gave the Open group an extra short questionnaire which asked in what per cent of the test questions did the student use the book.

The answers ranged from zero to 35%. The 10% mark divides the subjects into approximately equal groups. In the table below the scores obtained by those who used the book more can be compared with those of subjects who used it less (as usual, finished and unfinished subjects are separated):

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(continued)
Open Book
Use During Test

Open Group Subjects Who Had Finished Book					
Use of Book	N	Mean Prerequisite Score	Mean Pretest Score	Mean Posttest-2 Score	Posttest-2 Expressed as Percentage of Experts
Over 10%	4	16.0	9.22	32.0	80%
10% or less	4	15.25	10.00	24.0	60%

Open Group Subjects Who Had Not Finished Book					
Use of Book	N	Mean Prerequisite Score	Mean Pretest Score	Mean Posttest-2 Score	Posttest-2 Expressed as Percentage of Experts
Over 10%	5	12.4	4.50	19.4	48.5%
10% or less	4	10.8	6.25	13.5	33.8%

For both finished and incomplete subjects, those who used the book more during the test were more successful.

Subjects' Goals

Just before the posttest, subjects wrote down the grade they expected to obtain on the test. If we take this as some indication of the goals the subjects set for themselves, it is interesting to see how well they succeeded.

In the table below we have grouped the subjects' grade estimates into three classes: the first represents A's and B's (only one subject expected an A); the second, C's; and the third, D's and below. The body of the table shows the mean posttest-2 scores expressed as percentages of the experts' mean score.

Scores Predicted By Subjects	Open Group		Closed Group		Total	
	N	%	N	%	N	%
81-100%	5	78.0	6	71.3	11	74.3
71-80%	8	48.5	6	44.6	14	46.8
Below 71%	3	42.5	4	41.0	7	41.6

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(continued) Subjects' Goals

Those who expected to score between 80 and 100 on the material emerged with a fairly high score, 74.3% - which falls short of their aspirations, yet is a respectable showing on a difficult test after only two weeks' exposure to the topic.

Those who expected to make a C on the test were considerably short of the mark. Only six of the fourteen in this group had finished the book, so one wonders at the confidence of those who expected to score 70-80 without having finished it.

Even those six who did finish it did not do as well as they hoped - their average was 52.5% of the experts.

Those who anticipated doing poorly on the test were quite right; their score was only 41.6% of the experts. Five of the seven in this group had not finished the book.

The pre-study attitude survey asked subjects to indicate the grade they usually aspired to in their mathematics courses. If we separate the subjects into three approximately equal groups on the basis of their responses and then look at the posttest-2 scores for each of these groups, we get the following table:

Usual Grade Aspirations	N	Posttest-2 Means as Percentage of Experts' Mean
91-100	9	70%
81-90	12	51%
Below 81	8	36%

Naturally if we single out those who both had high expectations on this particular test <u>and</u> generally expect to do well in mathematics courses, we find a high-scoring group - average 78% (N = 4) on posttest-2 scores. Those who <u>did</u> not expect to do well either here <u>or</u> in their courses came off very poorly - 29% (N = 3). It is <u>not</u> feasible to consult other interesting combinations of the two goals indicators because the number of cases becomes even smaller.

In general the results on the probability test do follow with measures of the subjects' expectations (at least in terms of the ranking of the means). Among the important determinants of the goal indicators will be the students' general scholastic aptitude and his level of competence in mathematics at the time he came to the project.

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(continued) Subjects' Goals

The latter would be an especially strong influence presumably in the grade expected for the probability test. We examine the students' scores in relation to their mathematics background in the next section.

Mathematics Background

The prerequisite test gave us a measure of our subjects' present proficiency in simple math and algebra problems while their personal data record provided a listing of the college math courses they had taken.

From these two kinds of information we derived a loose measure of mathematics background by this procedure:

- for each kind of information a cutoff point was arbitrarily chosen to separate the subjects into a high and a low group. For instance, for the prerequisite test, those scoring over 75% were called "high," those under 75% went into the "low" group. In terms of mathematics courses, those who had taken calculus and beyond were called "high," those who had not had college calculus were put in the "low" group.

- for a composite mathematics background measure, we placed in a High group those who were high on both of the above dimensions. Those low on both went into a Low group, while those who were high on one but low on the other were assigned to a Medium group.

This classification resulted in twelve subjects in the High group, eight in the Medium group, and fifteen in the Low group. Since different members in each group finished the book, the results in this section will be based on complete subjects only. This reduces the number of subjects in the High group to nine, Medium group to three, and Low group to eight. Only 25% of the High group failed to complete the book while almost 50% of the Low group did not finish. This seems to be a result of the two week time limit imposed since the High group (N = 12) spent an average of 7.9 hours on the book while the Low group (N = 15) spent an average of 9.5 hours.

The probability-unit results for each group are shown next for those subjects who finished the book (Open and Closed groups pooled). The same data are shown in the accompanying graph.

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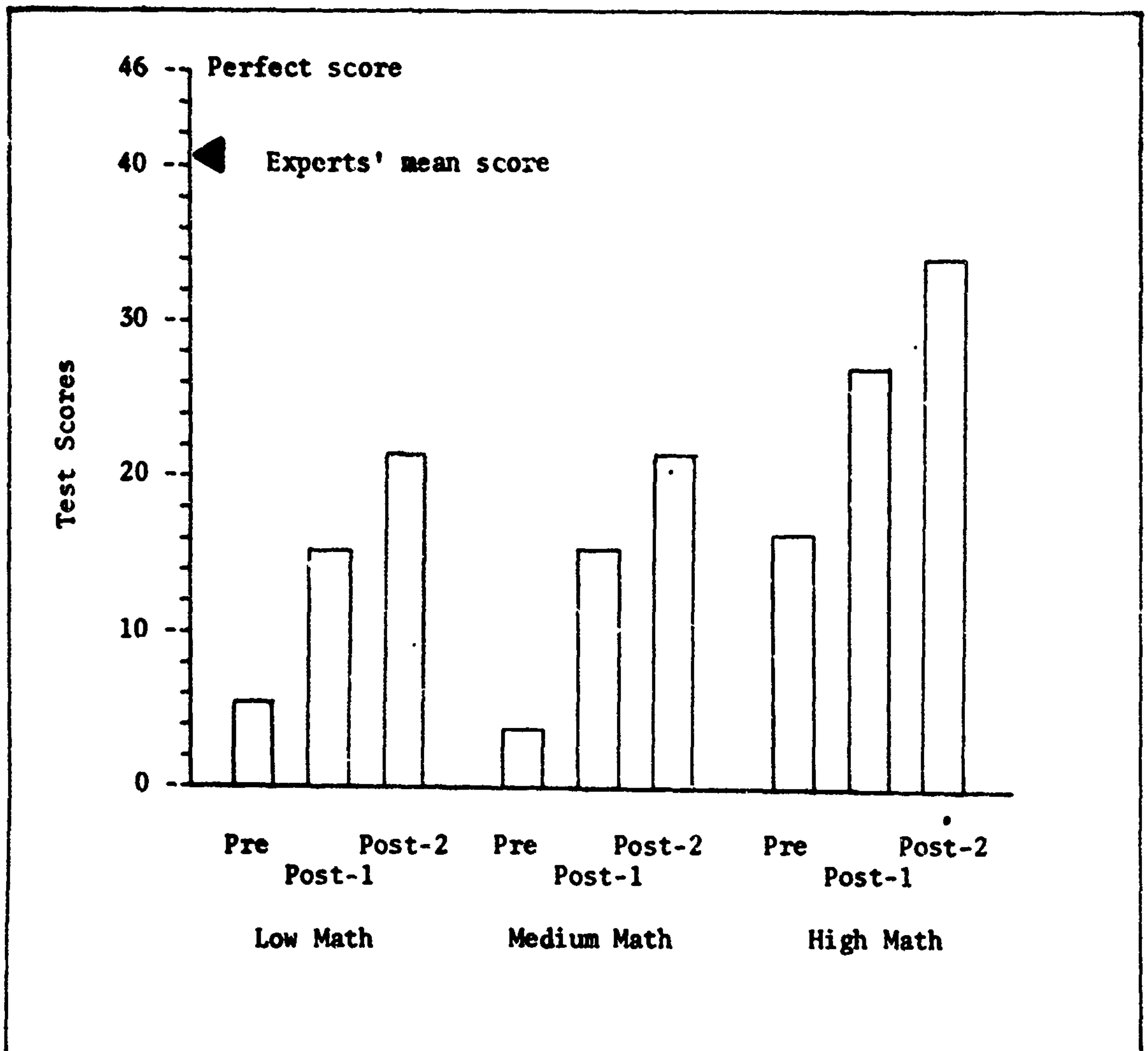
RESULTS, continued

(continued)
Mathematics Background

Aptitude Group	N	Mean Prerequisite Score	Mean Pretest Score	Mean Post-test-1 Score	Mean Post-test-2 Score	Post-test-2 as % of Experts' Mean
High Math	9	18.22	16.00	26.27	33.67	84.2%
Medium Math	3	13.67	3.67	15.67	21.67	54.2%
Low Math	8	9.25	5.50	15.50	20.88	52.2%



(continued) Mathematics Background

Those who are better prepared in mathematics do score higher on the pretest and posttests than do those in the Low group. It is interesting to note, however, that the gain scores for the groups are not dissimilar:

Aptitude Group	Mean Gain from Pretest to Posttest-1	Mean Gain from Pretest to Posttest-2
High Math (N=9)	10.7	17.7
Medium Math (N=3)	12.0	18.0
Low Math (N=8)	10.0	15.4

Reference Use Of Information Maps

On a logical basis the advantages of information map books for reference purposes seem obvious. Experimental evidence on the question, however, is not easy to come by because it is difficult to design realistic reference situations that are not "straw-man" demonstrations of information map superiority. We do have a few data that bear on the question, however.

The Harvard series had shown us that students in initial learning of a short course where the grade is inconsequential do not leaf back and forth, reviewing, comparing, integrating as they do in a semester-length college course. Thus their experience is not a very strong base from which to judge the book's utility as a reference tool. Consequently we decided to incorporate in the next tryout a task that would require moving back and forth through the book.

The open-book test for the probability course was made part of the experimental plan in order to obtain data on the book's use in reference for a real task - answering test questions. We have already reported that a disappointingly small number of students actually used the book during the test. And we have also reported that those who did use the book scored higher than those who used it very little.

For these same subjects we have responses to a short posttest questionnaire about their experience in looking up things in the book. We asked:

> "When compared with standard textbooks, looking up things in the information map book is . . . ."

Of the seventeen subjects in the Open group, one wrote "no opinion," two felt the books were the same, and fourteen wrote that the map book was "easier" or "better" or some such phrase.

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(continued) Reference Use Of Information Maps

Many of the latter group added comments such as:

> "interesting -- easy to find -- usually <u>exactly</u> what one is looking for."
>
> "much easier and very direct."
>
> "very easy reference."
>
> "it was clear and easier to use because I could follow through with examples."
>
> "easier. This is more concise and with the Related Pages much easier."
>
> "much easier and quicker. I can go right to the page to find the needed information."

Those who had used the book more during the test and those who rarely used it were equally favorable in answering this question. Two of the three subjects who were noncommital or neutral on the comparison were from the High mathematics background group, and the third was from the Medium group. But the fourteen who responded favorably were almost equally distributed over the High, Medium, and Low groups (4,5,5, respectively). Thus opinion about the book's utility for reference was not related to the mathematics background of the users.

Attitude Results

Since the attitude questionnaire for this study was longer than the ones used in the two previous studies, it is easier to present the results in two separate parts: attitude towards learning features of information mapping and attitude towards format.

The questions about learning features give the following results:

1. 89% thought that learning sets with the materials was effective; one (out of the 35 subjects) thought that the material was ineffective; the rest were undecided.

2. 63% thought that learning probability with the material was effective; 9% thought the material was ineffective, and the rest were undecided.

3. 75% thought they would retain the material presented better than with a standard text, two subjects disagreed with this, and the rest were undecided.

4. 85% would recommend the materials to others, one subject would not, and the rest were undecided.

5. When asked whether the material progressed too quickly, 26% agreed, 29% disagreed, and the remaining 45% said it was "just the right pace."

6. The section on sets was rated easy by 89% of the subjects, and just right by the remaining 11%.

7. The probability section was rated easy by 17% of the subjects, just right by 20%, and difficult by the other 63%.

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(continued) Attitude Results

The questions relating to the information map format evoked these responses:

8. 37% of the subjects agreed that there were not enough feedback questions and 51% disagreed; the rest were undecided.

9. 89% of the subjects thought the feedback questions were effective, one thought they weren't, and three were undecided.

10. 80% were interested in studying other subject matter written in this style, one subject didn't care one way or the other, and the others were not too interested.

11. 61% felt that they were able to work with the book for longer periods of time than with a standard textbook. 14% disagreed with this statement and the other 25% thought there was no difference.

12. 86% thought that the use of diagrams simplified the material, two of the subjects disagreed with the statement, and the other three were neutral.

13. 69% thought the examples in the book were interesting, 9% thought them uninteresting, and the other 22% had no opinion.

In addition to these multiple choice questions, there were a number of open-ended questions which asked about various features of the material.

When asked to list the ways this book was different from a standard text, some of the responses and the number of subjects who gave each were:

- talked, asked questions, and explained answers (7)
- clear examples (2)
- more simplified and clarified (5)
- logical grouping of ideas (16)
- repetitious (2)
- immediacy of feedback questions (11)
- easier to stop and start studying (1)
- explained material better (1)

We also asked which features of the book were not helpful:

- some introductions too long (2)
- explanations too involved (1)
- confusing formulas (1)
- two week time limit too short (1)
- having to work completely independently (1)

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(continued) Attitude Results	Some of the responses to what features of the book were helpful: . diagrams explaining formulas (4) . numerous examples (5) . alternative approaches to a given problem (3) . feedback questions (13) . reviews with answers given (11) . division into concepts (5) When asked how we could improve the book we got the following responses: . add more interesting examples (2) . add more review sections (2) . add more detailed explanations (2) . add more examples on complex material (7) . add more time on complex probabilities (4) . add more feedback questions (2) . delete some of the material on sets (2) Some of the individual comments were (the letters H, M, and L refer to the subject's math group - high, medium or low): · first math "course" that ever got through my mental block (L) · with this text I was secure with a math book. This is phenomenal for me! (L) · much more boring and repetitious than a standard text (H) · more fun to read (M) · reader more active in learning (M) · compared to other math books I found this to be a great improvement (L) · extremely repetitious (H) · bored with approaching each topic in the same way - organized but not stimulating (L) · missed having a teacher for aid (L) · don't like feeling like an automation machine - want to select information not react to it (H) · easy to work with; efficient means of learning (H)
General Discussion	Based on their answers to all the attitude questions, thirty of the thirty-five subjects (85.77%) had a favorable reaction to the learning materials, three were indifferent, and two had an unfavorable reaction. The subjects who were weak in mathematics were very favorably disposed and perhaps would have done better on the achievement test if they had more time to study.

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(continued) General Discussion	Most of the unfavorable comments came from those subjects who were quite good in math. Their usual comment was that explanations were too long, boring, etc. When we looked at their books it was evident that they had gone through all the material and all the feedback questions even though we stated in the introduction that the book was designed so that examples could be skipped and feedback questions answered only when the student was having difficulty. The few unfavorable comments of those who had weak math backgrounds were generally confined to lack of time and the desire to ha a teacher available to answer questions that came up so the could go on with confidence.
Limitations of the Study	The principal shortcoming of this study lies in the atypical motivational conditions. One of the key principles of modern learning research relates learning and memory to the degree of motivation aroused. Among the important incentives commonly employed to motivate students are grades and the approval of the instructor. In the laboratory situation, monetary rewards are often used to manipulate the subjects' motivational level. In our evaluative experiment with the probability book, these common incentives were absent. The grades the student achieved on our tests were of no consequence to him, would not affect the future course of his educational career one bit and in fact would never even become known to him. Although he was paid for coming to take part in the series, his rate of pay was in no way geared to his level of achievement; as we saw, many subjects did not finish reading through the materials. There was not the "cramming" for an exam that so often typifies (unfortunately) the college course. The time of year when this series occurred was one where student morale and enthusiasm for study were at their lowest ebb -- at the end of the school year just after final exams. Most subjects had just started on their summer jobs. What motives were operating to make them take part in the experiment and to study the book as many hours as they did (5 to 14)? We know that many came because the project seemed a painless and interesting way to earn some much needed money; some came as a favor to the investigators; a couple came because they saw an opportunity to prepare for a similar course required next term by their college program.

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(continued) Limitations of the Study	Whatever may be the needs and interests that drew our subjects to participate in the study, we are confident that they were less intense than the motives ordinarily operating in the situations for which these learning materials were intended. Of our results it is safe to say that they represent outcomes obtained under <u>minimal</u> motivational conditions. In other circumstances (in college courses, job-training classes, etc.) where internal and external incentives are operating at customary levels and where sufficient time is available for assimilation, we can reasonably predict markedly increased effects.

NOTE ON STATISTICAL DETAILS

The Multiple Analysis of Covariance

The multiple analysis of covariance used the prerequisite test (X_1) and the pretest (X_2) as covariates for the posttest (Y). The analysis of sums of squares and products was as follows:

	d.f.	Σx_1^2	Σx_2^2	$\Sigma x_1 x_2$
Between groups	2	1.63	21.71	-5.95
Within groups	50	1141.12	2700.10	897.27
Total	52	1142.75	2721.81	891.32

	d.f.	Σy^2	$\Sigma x_1 y$	$\Sigma x_2 y$
Between groups	2	787.09	6.89	-21.79
Within groups	50	3512.08	1152.63	2166.72
Total	52	4299.17	1159.52	2144.91

The regression coefficients are estimated by solving the simultaneous equations:

$$1141.12\underline{b}_1 + 897.27\underline{b}_2 = 1152.63$$
$$897.27\underline{b}_1 + 2700.10\underline{b}_2 = 2166.72$$

which results in:

$$\underline{b}_1 = .513$$
$$\underline{b}_2 = .632$$

The deviations sums of squares were:

	d.f.	SS	MS
Total	50	2348.68	
Error	48	1551.36	32.32
For testing adjusted means	2	797.32	398.66

The F test of the adjusted means results in:

$F = 12.33$ (2,48 d.f.; $P < .001$)

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(continued) The Multiple Analysis of Covariance	The effective mean square per observation is: $s^2 = 32.72$ (This is an adjusted error mean square - see Snedecor and Cochran, 1967, p. 441.) The Studentized Range Test (Q) may be used to compare the differences between adjusted means. The upper 1% point of Q for three means and 48 d.f. is approximately 4.33. The average standard error of a mean is 1.39. Thus, any difference which is greater than (4.33)(1.39) = 6.019 is significant at the 1% level. Since the difference between open and control is 8.38 and the difference between closed and control is 8.17, both of these differences are significant at the 1% level.

CHAPTER 7 OVERVIEW OF THE EVALUATIVE STUDIES

Introduction

First of all, two points about evaluative studies in general:

- The experimental data bear on the specific product and not on the method. Just as one given textbook cannot be considered as representative of so broad a category as "textbooks in general," so the information map units we have tested are only one sample of the possible products of the information map method.
- There are limits to what can be accomplished by one series of researches on any topic.

Achievement Data

The evaluative studies have shown some of the effects that we can expect from the use of this information map book under different conditions. After 8 to 10 hours of study in a setting free of the usual educational pressures, students showed significant evidence of learning. That fact in itself is not surprising in view of the empirical tryouts and revisions that the program underwent throughout its development.

The problem of trying to say anything meaningful about the magnitude of gains from learning materials is a perennial one in educational research. The arbitrariness both of the criteria set by the program developers and of the difficulty level of the tests make it impossible to compare gains across evaluative studies. One set of criterion tests may be very easy and a spectacularly high percentage of students pass them compared with the gains from another program with more difficult criterion tests.

In short, since the criteria and the difficulty level of the tests are the result of the individual developer's judgment, much of the data from evaluative studies are properly termed "ipsative" - self-serving, without an external reference point.

Our own test of the probability unit were purposefully made difficult for reasons of experimental design, as Chapter 6 explains. In the absence of any standard achievement tests to use for comparison, it is difficult to assess the size of the gains.

In an effort to provide some external anchor point for judging the effect of the probability unit, we resorted to comparing the students' scores with those of our "experts" on the same test.

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(continued) Achievement Data

To further aid in weighing the value of the program, we present in the appendix the actual tests used for the probability unit. There the reader may note the range of content covered and the difficulty level of the material. These together with the performance data reported in Chapter 6 constitute the main evidence for the unit's value.

In the end, whether or not the program has achieved worthwhile results is a matter of individual subjective judgment, and that is related to the use for which the specific product is being considered.

Attitude Data

The difficulty of trying to establish an objective standard for comparing educational programs has led some researchers to turn to attitude data as being more revealing about the attractive power of a program. Although we do not abandon hope of solving the methodological issue, we do attach importance to the user's reactions to the learning materials. His willingness to approach and to interact with the materials encourages the hope that the materials may communicate with him.

The reactions of our students to information maps were generally quite favorable, especially among those for whom the materials were intended, those with weak backgrounds in mathematics.

In general, our subjects rated the materials effective, said they would recommend them to others, and singled out many of the special features for favorable mention.

Whether the effects of the sets and probability book are attributable to the novelty of the method cannot be determined in the time-framework within which we operated. The so-called Hawthorne-type reactions can be both hostile and enthusiastic. Only in extended tryouts with the same subjects can we determine whether the learning materials are still looked upon favorably by students.

Conclusion

In working with a new system, we have made only a beginning at collecting information about how subjects react to the learning materials. We have sampled only a narrow range of subject matters. We have only begun to ask questions about how specific factors or features of the materials contribute to the learning outcomes. One set of experiments with a single product can only begin to map out the areas that may be important.

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(continued) Conclusion	Our initial task was to explore the effects of information-mapped learning materials and to decide upon the feasibility of further work with the method. The initial research is promising but more experiments and wider experience are needed if we are to be able to generalize about the method. This is not to say that a strong logical case cannot be made for the method's advantages. We will consider this in the final chapter.

CHAPTER 8 INFORMATION MAPPING AND COMPUTERS

A LEARNING-REFERENCE SUBSYSTEM

Introduction	During the development of information map books, we began to see how the information mapping categories could be applied to organizing a computer data base for learning and reference purposes. We explored some of the aspects of developing a multi-purpose data base organized in this way and we carried out exploratory design work on animated display possibilities. Some preliminary tryouts of learning from information map displays re made with a simulated display unit.
Background	The capabilities of a large computer facility permit it to be a significant training vehicle for its users. Therefore, it is desirable for such a facility to include a learning-reference subsystem. The success of such an information utility depends in a very critical way on the organization of the underlying data base and the flexibility with which it can serve different purposes.
Data Base	We conceived of a data base as consisting of interrelated networks of information segments. This gives a flexibility in using only those parts of the system that are required for a particular purpose. Since information maps are composed of separable labelled blocks of information, they can easily be adapted for this type of data base.
Sequence Generators	A common data base to serve varied purposes would require a set of "sequence generators". These would be rules or patterns for assembling and displaying information blocks, depending upon the objective of the user. The browser would obviously not want to see the information in the same sequence as would the user with a specific reference problem. The purposes of initial learning, reviewing, briefing, updating, and so on would all require different information sequences. The information map books are arranged according to sequence generators derived from considerations of learning theory, instructional technology, and human factors engineering. For some purposes, the sequence generator could allow considerable control of the system by the user -- for reviewing, browsing, and reference uses, primary control should reside with the user. For initial learning, the sequence generator could permit a limited number of user options, but major control should probably remain with the system.

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Query Language	User control of the system is provided by the query language which is the set of all commands that are available to the user. For example, the user may have available commands which allow him to look up a particular page or topic, go to a set of feedback questions (or omit such questions), etc. The extent of user control in the system is indicated by the complexity of the query language.
Updating	From time to time, there will arise a need to modify the data base. An information mapped data base, because of its separate blocks of information, would probably minimize the cost of updating or improving the data base.

ADVANTAGES OF USING INFORMATION MAPPING FOR A LEARNING-REFERENCE SUBSYSTEM

Multiple Purposes	The flexible block-identified data base can be rearranged for:
	
	· initial learning
	  · for the naive student
	  · for the sophisticated student
	· relearning or review
	  · for a comprehension test
	  · for a performance test
	· reference (reminder or look-up of a specific bit of information)
	· briefing and browsing (what is this subject matter about in general terms?)
	· updating skills and information (unlearning and new learning)
	· job-aid (preparing checklists, menus, and other types of job aids)

User Options	The user may: · exercise a preference in sequencing of information blocks · choose different levels of feedback questions · choose when to see the feedback question answers · choose whether he wants personal or system control of review · choose details of a personal review method (e.g., via feedback questions, condensed summary pages, definitions only, etc.)
System Options	The system can respond to individual differences such as learner purposes. It can give mathematical proofs to the mathematically inclined learner and omit them for the person who is only interested in learning the subject matter procedurally.

DISPLAY OPPORTUNITIES

Introduction

Computers with display scopes have great potential for making learning and reference work more effective. Considerable research is needed to explore the advantages of different scope applications.

The capacity of the computer to permit the user to exercise his individual preferences may be an important part of effective man-machine partnership. One option that could be made available to the user would be the choice of a number of types of displays.

Not everyone wants to have information displayed to him in the same way. For example, if you are learning something for the first time you may want a complete version of the text. If you are reviewing or just browsing through a large body of material you may want less.

Many people like tables, charts, and graphs, while others prefer their information in uninterrupted prose. Information mapping can easily be adapted to accommodate both.

Dynamic Displays

Another promising possibility is the development of animated displays along with research into their impact on learning and reference work. Five possible uses of dynamic displays are given below:

Uses	Description	Possible Advantages
Guided reading	In the guided reading type, we reveal parts of a display to the user. For example, different parts of a table might be shown.	• Ensures that new users of information maps use them to full advantage. • Paces reading rate. • Focuses attention.
Vary level of detail	In this type, different levels of detail or abstraction appear during the display. For example, a tree is shown with just the names of main concepts, then with the next sorting into finer level groups.	• The user's field of vision is not over-clogged with detail. • Relationships between different levels of abstraction and detail are revealed.

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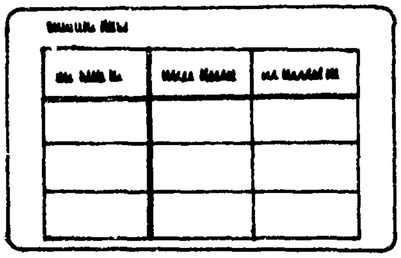
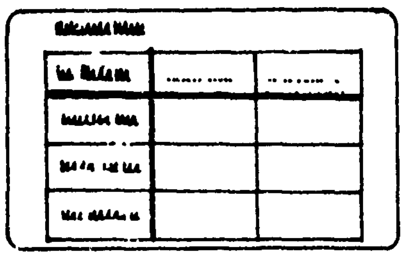
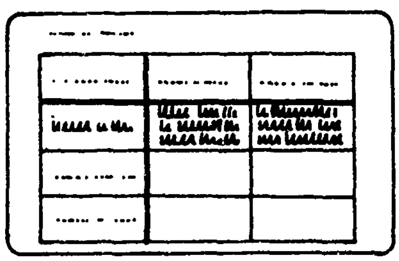
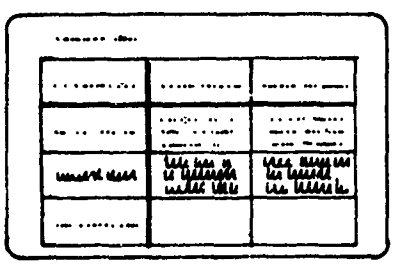
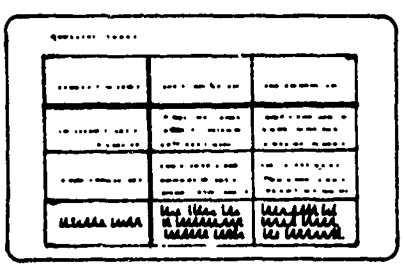
DISPLAY OPPORTUNITIES, continued

Uses	Description	Possible Advantages
Show movement in a sequence network	In sequence networks, there is a movement either logically or in time. We can display this movement in a dynamic display. We can also show interrelationships between two moving systems.	. Highlight thing being talked about. . Focus on parts and relationships in whole.
Explode, implode parts of structure	Structures are made up of parts. Diagrams can be "exploded" by a common drafting technique in dynamic terms.	· Show how structures fit together.
Highlight an important learning point	Flashing (or momentarily appearing) arrows, labels, and other visual techniques adaptable from the world of movie and television.	· Focus attention of user. · Maintain attention of user.

ONE APPLICATION OF DYNAMIC DISPLAYS

Time Segment	Display Screen	Comment
1		Name of table, main headings, and outline of table flash onto screen.
2		Names on left axis appear while names of main headings recede (but do not disappear).
3		Successive horizontal blocks of information appear. As each "line" of blocks appears, the other lines recede to a lesser character size or are reduced to a lesser brightness.
4		
5		

EXAMPLES OF DISPLAY OPTIONS

Introduction

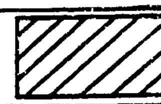
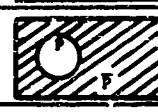
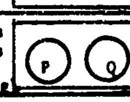
The next two sample pages illustrate how the same information can be presented in two different ways. Even for initial learning purposes some students prefer a chart where they can observe the relationships themselves, while others would rather have a verbal description of the material. For later review and reference work, however, the tabular format would presumably be most favored.

The first example shows the summary table from the end of the sets unit.

Example

47

CONDENSED SUMMARY OF SET THEORY

SYMBOL(S)	NAME	MEANING	VENN DIAGRAM	SEE PAGE
U	Universal Set	The set of all elements in a given study.	Shaded part is U.  U	14
∅	Null Set	The set containing no elements		13
⊂	Subset Symbol	"...is contained in..."	Shaded part is subset.  U	11
P Q	Names of Sets	Any capital letters may be used to name sets, e.g. A, B, ...Z.	 U	4
$\bar{P}$	Complement	Set of all elements in U not in P.	Shaded part is $\bar{P}$.  U	27
∈	Element Symbol	"...is an element of..."		6
∉		"...is not an element of..."		6
P ∪ Q	Union	Set of all elements in P or Q or both.	Shaded part is P ∪ Q  U	30
P ∩ Q	Intersection	Set of all elements common to P and Q.	Shaded part is P ∩ Q.  U	35
P − Q	Difference	Set of all elements in P but not in Q.	Shaded part is P − Q.  U	44
P∩Q = ∅	Disjoint Sets	Sets which have no members in common.	Shaded part is P∩Q, which is empty (therefore no shading).  U	42

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(continued) Example

The second example shows the same information presented in prose form (only half of the information in the first table is given in this example in order to save space; in practice, of course, all the information would be presented):

CONDENSED SUMMARY OF SET THEORY

The symbol U stands for Universal Set, which is the set of all elements in a given study. Venn Diagram:

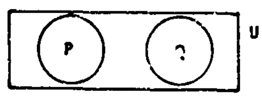
The shaded part is U

The symbol $\emptyset$ stands for the Null Set, which is the set containing no elements. There is no Venn Diagram of the Null Set.

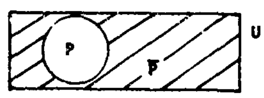
The $\subset$ is the Subset symbol and means "...is contained in." Venn Diagram:

The shaded part is the subset.

Any capital letters may be used to name sets, e.g., A,B,...Z. Venn Diagram:



The symbol $\bar{P}$ stands for the Complement of a set, which is the set of all elements in U <u>not</u> in P. Venn Diagram:



The shaded part is $\bar{P}$.

The $\in$ is the Element symbol and means "... is an element of..." There is no Venn Diagram.

The $\notin$ is the symbol which means "...is not an element of..." There is no Venn Diagram.

SIMULATED COMPUTER DISPLAY UNIT

Introduction

In order to have a glimpse of the difficulties and possibilities of applying information mapping to computers we constructed a simulated computer device.

The "computer" is operated by a research assistant who follows an algorithm that tells him how to respond to different commands given by the user. The user communicates with the "computer" by writing commands on cards.

The research assistant finds displays manually in a file box, slips them into the display device and records data on the interaction such as time, display asked for, etc. The displays used were the pages of the information map book on sets and probability.

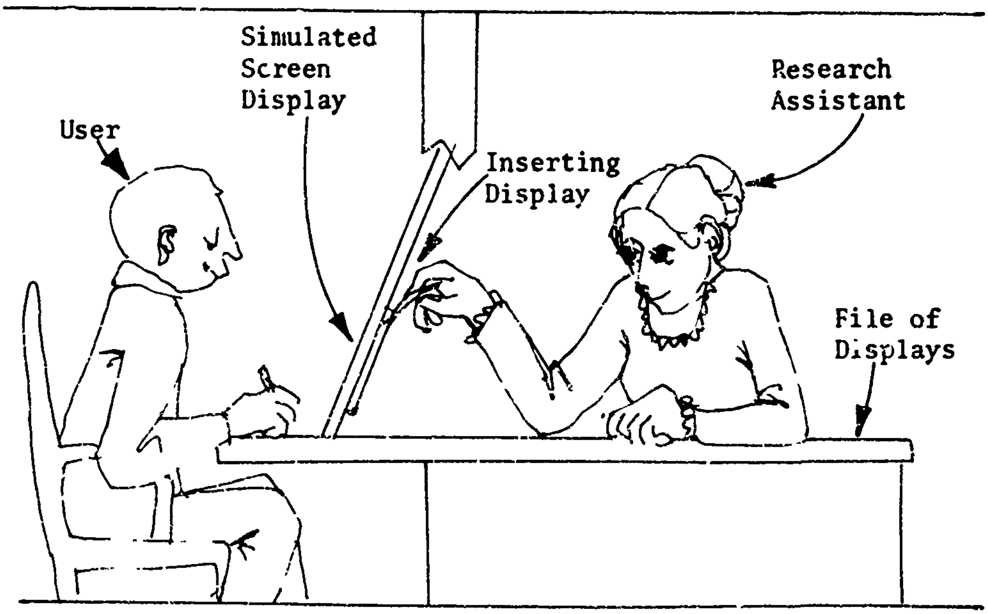
Objectives

This display unit was built primarily as a tool for possible future research in application of information mapping to computers. Thus, we were primarily concerned with the following questions:

- Is the simulation a reasonable one, i.e., does the user actually react as he would with a computer based learning-reference system?
- How complex a query language could the research assistant handle?
- Can we identify specific pages that cause the student trouble?

The last question, of course, is concerned with revision of the book pages. Thus, the simulated display unit served as a developmental test vehicle.

Diagram



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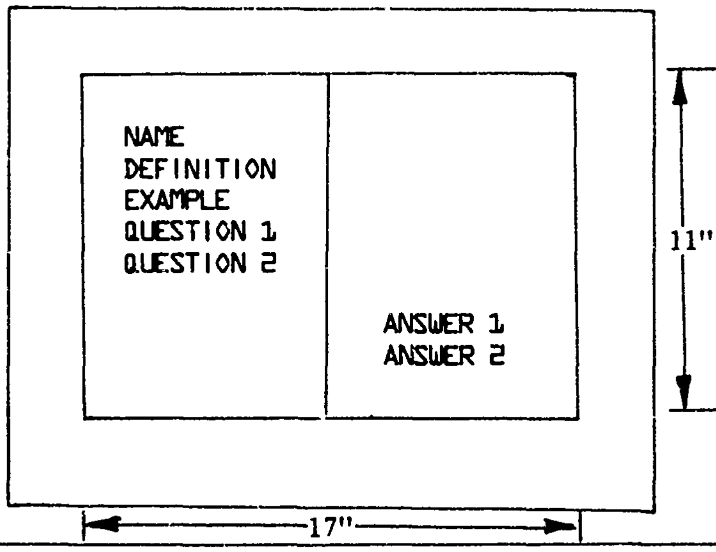
Dimensions of Display Screen



User Behavior	Only a few students were run on this device so a more definitive answer to the first question is not possible. However, from interviews with those who tried it, we got the impression that the user easily entered into his role, became forgetful of the research assistant behind the screen, and tended to act as if it were a "real machine."
Query Language	The query language we used had provisions for referencing a table of contents or any previous page or topic. In addition the user was able to determine whether or not he wanted feedback questions or review questions. The average time for an experienced research assistant to respond to a user command was about 7 seconds. We found this delay to be acceptable to the users (although we hope it can be reduced still more).
Developmental Test Aspect	The results of the data on time per page gave us an indication of those pages that gave students trouble. Other indications came from questions asked by the user during the session. These pages were, of course, revised. In addition, since the student always had the opportunity to ask for feedback questions after each topic, we were led to insert a few of these pages where we previously thought them unnecessary.

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(continued) Developmental Test Aspect

Some time data for two subjects who learned from the sets and probability units are shown here:

Time Factor	Fastest Student	Slowest Student
Average time spent per IM page	1.1 min	2.5 min
Range of time spent per IM page	0.25 - 2.50 min.	1.00 - 6.33 min.
Average time spent per feedback question page	2.4 min	2.8 min
Range of time spent per feedback question page	0.25 - 5.92 min.	0.50 - 8.83 min.
Total time at display	2 - 1/6 hours	4 hours

Conclusion

The simulation approach was a feasible way to begin investigating properties of query languages and different types of displays in an inexpensive setting without the long waits associated with hardware installation and software preparation. We found it was possible to collect meaningful experimental data on various display research issues and we believe that much useful work can be done with such simulated units.

CHAPTER 9 PRODUCTION COSTS

Introduction

During the project we wrote a total of approximately twelve hours of material on sets, probability, and permutations and combinations. Although we kept records of the amounts of time spent on the different aspects involved in production, these time figures are confounded with the time we spent defining and redefining the information map system. Now that the system has been established, these records are not representative of the time an experienced writer would spend at the task.

In order to obtain a more realistic estimate the authors tried to adjust the figures to reflect what might be involved in the production of an information map book. Thus, the costs we present are estimates based on the consensus of the authors.

Cost Estimates

The total cost of the production was approximately $12,000. As indicated in the evaluation chapters, the combined average time to study the book was about twelve hours (note that no single group in the evaluative studies actually went through the entire book; some read only sets and probability, while others read only sets and permutations and combinations).

We estimated that the breakdown of time spent on the different aspects of the production system was as follows:

Curriculum planning	25%
Writing and editing	55%
Developmental testing	20%

Thus, the cost-per-hour breakdown is as follows:

Curriculum planning	$250
Writing and editing	$550
Developmental testing	$200
Total	$1000

Training the Writers

Since we have developed the system, we have no data on the training costs which might be involved. However, we do have experience with training of one new writer who came on the staff after the preliminary system was developed.

The indication from this experience points to the need for a one or two week training course (reading appropriate research

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(continued) Training the Writers	and actual examples of information map books) plus a month or two of writing experience under a competent editor. This assumes that the potential writer is a subject matter "expert" and that the editor is well versed in the application of learning research to instructional materials.
Comparison with Programmed Instruction	Based on his experience as Vice President of Marketing with Basic Systems, Inc., Murphy (1967) estimates that a typical cost-per-hour of programmed instruction might run between $2500 and $3000. Murphy's figure includes direct costs plus an overhead estimated at 100% of direct. Deleting the physical production costs, Murphy's direct cost-per-hour runs between $1125 and $1375. Murphy's figures also include analysis of training requirements which involve in his case working with a client. We would expect that our curriculum planning involves the same type of work and so is more or less comparable. Thus, we expect that information mapping costs will be approximately the same as those of programmed instruction. However, we feel that we have produced a more versatile product (one that serves both initial learning and reference uses).
Comparison with Computer-Assisted Instruction	Stolurow (1969, p. 308) says "It is difficult to determine the cost, but one approach is to estimate that as little as 100 hours of development time goes into one hour of student time. Estimates up to 400 hours have been made, but definitive data are not available. If the average cost per hour for the writers and technical personnel is estimated at $12, then the cost would vary from $1200 to $4800 to produce one hour of student instructional material. Other costs also are involved, but hard to estimate. They include key punching, typing, artwork, machine loading, and the like." Carter and Walker (1969, p.333) use the Suppes figure from Stanford University of $5,000 per student hour for a drill and practice mode and assume a $30,000 cost per hour for tutorial. They do usefully point out that spread over 100,000 users, the instructional materials development costs are only 3 to 6 percent of the total CAI system.

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Conclusions

Perhaps the only concensus that can be reached on "average" costs of either computer-assisted instruction, programmed instruction, or information mapping is that definitive data are not available.

Even if data were available, however, their interpretation would be subject to a great deal of debate. In discussing decision-theory approaches to the problem of instructional research, Lumsdaine (1963, p. 667) pointed out "our general inability to make reasonable estimates of the costs, and, particularly, the anticipated payoff of educational procedures."

CHAPTER 10 SUMMARY OF INFORMATION MAPPING

REVIEW

What It Is	Information mapping is a method of organizing categories of information and of presenting them in formats that communicate quickly with the user.
What It Is For	Learning and reference work are the primary applications anticipated for the system.
Where It Came From	The procedures and techniques of information mapping are derived from the resources of the education world and incorporate effective applications in display and communication technology.
How It Is Used	Information mapped materials may be produced in book form or organized into data bases for computer-aided instruction. In books designed for initial learning and reference, the information is carried in clearly labelled information blocks, arranged in an order prescribed for the kind of information involved. Other features of these self-instructional books include feedback questions and answers, special maps to facilitate learning and retention, charts and displays for easy retrieval of topics for review and reference purposes. For multi-purpose computer systems, an information mapped data base would be composed of separable labelled blocks of information together with their interconnections. Only those parts of the blocks required for a specific purpose need be called up. This flexible system would permit the user to organize sequences of blocks and to display them in the order that best serves his purpose, whether it be learning, reference, or browsing.
Main Product	Most of the research and development work so far has involved book versions of topics in mathematics and computer languages. The primary product of this new system for which we have experimental data is a self-instructional book on sets and probability theory for college students with minimal preparation in mathematics.
How It Was Developed	One of the main tenets of information mapping is that the most reliable way to obtain program effectiveness is to make empirical testing and revision an integral part of the design and development process. Thus the book on sets and probability was shaped, corrected and improved by tryout-and-revision cycles.

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Evaluative Studies — The information mapped book served as the research vehicle for several evaluative studies of initial learning by college students. We have described the significant effect the book had on the students and we have presented the results of attitude studies showing that students find the materials attractive and valuable. Whether this favorable response is colored by the novelty of the approach cannot yet be determined for so new a technique.

Computer Simulation — Preliminary spadework was carried out with simulated computer displays. This was done mainly to see whether the simulation approach was feasible for exploring whether certain options might be desirable in future computer applications: query languages, information-sequencing rules, dynamic displays, and so on. The approach seems a useful and economical way of researching practical issues without a heavy investment in computer facilities.

Cost Estimates — The production of learning materials in college-level mathematics was estimated to cost about the same as programmed instruction. However the versatility with which information mapped materials can be adjusted to a variety of purposes gives it obvious cost advantages over single-purpose methods.

THE INFORMATION MAP METHOD

Introduction

We said earlier that our research related primarily to the specific product tested, the sets and probability book. It would be a logical fallacy to interpret the results as validating a method if this be conceived of as the whole class of products that might arise from information mapping techniques.

Our research had the practical objective of evaluating the specific program, but it was also a beginning in the task of learning more about the method by testing hypotheses about the influence of certain factors and variations in conditions.

The results of a short series of experiments are necessarily limited in their generalizability, but we consider the effects strong enough to warrant further development work.

The Logical Case

If we cannot generalize from the empirical data to the "method," we can nevertheless make a logical case for believing that the method is a promising one. In the first place, it draws upon the resources of the education world, embodying factors for which there is already support in research or practice.

Another reason for expecting the products to be effective is that they are developed by the process of "formative evaluation," as Scriven (1967) has called the process of empirical testing and revision throughout development. In this respect, the information map product has the advantage of a steady stream of learner-response data from all areas of the program. These are the basis for program improvement so that a desired level of proficiency can be obtained - in this it parallels programmed instruction.

Thus since the effectiveness of given products can be engineered by practical procedures, there is little point to arguing whether information mapped programs are as effective as programs produced by other prescriptions. The information mapping approach, however, has certain unique advantages over other methods. Some of these are indicated on the next page.

SOME ADVANTAGES OF INFORMATION MAPPING

Multi-purpose	Information mapping is a flexible multi-purpose system. Its base of classified information blocks permits it to be used: • for book production • for computer-based programs

Learning and Reference	The separable labelled blocks can be drawn from the information base as needed and assembled into sequences suitable for:
	• initial learning
	  • for the naive student
	  • for the experienced student
	• relearning or review
	• reference uses
	• browsing or briefing
	
	Where computer scopes are available, the information blocks may be presented with a variety of display options such as:
	• static versus dynamic displays
	• whole versus sequential display of parts

Updating	The block-identified and cross-indexed information base can be easily modified; therefore, the task of updating the changes in a system is relatively simple.
User Options	The flexibility of the system would permit the user options that are not available with other methods. The user may custom-tailor his own program by calling up only those information blocks that he requires for his specific purpose.
Correction	Programs for initial learning have a built-in correction function: practice questions and answers monitor the effects of each map. Therefore it is easy to identify and modify the trouble spots.
Retrieval	Whether in book version or in computer-adapted form, the ease with which information can be retrieved is obvious: informative tables of contents, maps beginning on a new page, map titles, marginal labels, consistently located classes of information, related page numbers at end of maps, charts, summary tables, indexes -- all are designed for swift communication with the user.

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Different Audiences	The flexible block format enables one to adapt each learning or reference program to the special interests of student groups. For instance, the worked examples and feedback questions of our probability unit were geared to situations of interest to students of the behavioral sciences. The same probability text can be modified for medical students or business students by replacing the blocks of worked examples and the pages of practice questions.
Research Advantages	Research advantages of a system so organized are manifold. Since the content characteristics of the materials can be specified, variations in the make-up of learning materials can be systematically varied with relative ease. For example, the effects of varying the number of worked examples or of changing the amount of redundant information could be explored. With computer capabilities, many questions concerning the optimal complexity of displays and the desirable degree of learner control over instructional sequencing can be researched more economically with a flexible, modular system.
Comment	It has been remarked that the venerable textbook with its two distinctly different functions as both learning medium and reference source may soon disappear and be replaced by programmed instruction plus "the well designed reference handbook" (Lumsdaine, 1963, p. 586). It seems that a better solution m[illegible] in inf[illegible]ation mapping.

APPENDIX

MAP CLASSIFICATION CHART

Types of Maps	Description	Information Blocks
Concepts	A concept may be a · technical term · generalization sentence · property sentence · rule sentence · relationship sentence	· name of the concept · definition or description · criteria · generalization · formula · use (purpose or function, worth, value) · example · non-example · introduction · synonym · notation · diagram · comment · properties · analogy

Structures	A structure is:
	· a physical thing, or
	· something which can be divided into parts which have boundaries.
		· name of structure
		  · meaning
		  · function
		· /all of the concept blocks/
		· parts and subparts
		· boundaries
		· diagram (or illustration, picture)

Processes	A process is some structure changing through time. The description of a process involves writing about what happens during successive stages of time.	· name of process · /all of concept blocks/ · /all of structure blocks/ · purpose of process · stage · function of the part · cycle · input · result (output) · occasion for starting · changes · time · state

continued on next page

MAP CLASSIFICATION CHART, continued

Types of Maps	Description	Information Blocks
(continued) Processes		· condition · cause · effect
Procedures	A procedure is a set of steps performed to obtain some specified outcome.	· name of procedure · /all of concept blocks/ · given · step/procedure · example · when to use · when to stop · decisions
Classifications	Classification is the sorting of things by concepts into categories by the use of one or more sorting factors (criteria).	· name · sorting factor · subclass names · purpose of sort
Decisions	Decision tables display actions prescribed for different conditions.	· name of decision · "if" parts (or conditions) · "then" parts (or actions) · example
Facts	Facts are sentences containing arbitrary associations of such things as symbols, measurements, dates associated with events, experimental results. How a fact is presented depends on the context.	· statement of fact
Proofs	Proofs are generally used in mathematical subjects for more difficult theorems.	· assumptions · to prove · statement · reason · example

TEST-A USED IN RESEARCH REPORTED IN CHAPTER 6

1. Match the notation on the left with the correct term on the right.

____ $P(A \cap B)$	a. probability of the complement of an event
____ S	b. empty event
____ $P(\bar{A})$	c. sample space
____ $P(A \mid B)$	d. conditional probability of one event given another
____	e. probability of the intersection of two events
	f. independent events

2. There are five balls in an urn. Three are black and are numbered from one to three, and two are white and are numbered four and five. We draw a ball at random from the urn.

   A. Assign probabilities to the elementary events. ____________________

   ____

   B. Find the probability that the ball drawn had an odd number and was black. ____

   C. Find the probability of the complement of the event in question B. ____

   D. What are the odds in favor of drawing a white ball? ________________

   ____

   E. What is the conditional probability that the ball is black given that the number on the ball is odd? ____________________

3. If event A and event B are mutually exclusive, find $P(A \cap B)$. __________

____

4. We have two urns. Urn I contains three white and two black balls, and Urn II contains six black and three green balls.

   A. If we choose two balls at random from Urn I without replacement, what is the probability that they are both black? ________________

   B. If we choose two balls at random from Urn II with replacement, what is the probability that they are of different colors? ______________

   C. If we choose a ball at random from the first urn and then independently choose a ball at random from the second urn, what is the probability that neither ball is black? ____________________

D. We are going to choose two balls from the urns in the following way: Choose the first ball at random from Urn I. If this ball is white, replace it and choose the second ball at random from Urn I also. If the first ball is black, however, put it into Urn II and choose the second ball at random from Urn II. What is the probability that both balls are of the same color? ____________

5. A card is drawn at random from a standard deck. What is the probability that the card is a heart or a picture card? (Jack, Queen and King of each suit are the only picture cards.) ____________

6. If A and B are independent, and P(A) = .8, P(B) = .3, find the probability that A or B occurs. ____________

7. A coin is tossed five times, or until a head appears, whichever comes first. The probability of a head on any toss is 1/2 and the tosses are independent.

   A. List the points of the sample space. ____________

   ____

   B. Assign probabilities to the elementary events. ____________

   ____

   C. What is the probability that the coin is tossed less than five times? ____________

   D. What is the conditional probability that the coin is tossed five times given that the first three tosses all result in tails? ______

   ____

8. A sample space contains 25 sample points, and the event A in the sample space contains 10 points. Find the probability of the complement of A, assuming all the outcomes are equally likely. ____________

   ____

9. A fair coin is tossed five times. Find the probability of getting at least one head. ____________

TEST-B USED IN RESEARCH REPORTED IN CHAPTER 6

1. Match the notation on the left with the correct term on the right.

____ $\emptyset$	a. probability of an elementary event
____ P (B|A)	b. empty event
____ P ({0})	c. sample space
____ P (A∪B)	d. independent events
	e. probability of the union of two events
	f. conditional probability of one event given another

2. There are ten balls in an urn. Three are white and are numbered from one to three, and seven are black and are numbered from four to ten. We draw a ball at random from the urn.

   A. Assign probabilities to the elementary events. ____________________

   ____

   B. Find the probability that the ball drawn had an odd number and was black. ____

   C. Find the probability of the complement of the event in B. __________

   ____

   D. What are the odds in favor of drawing a white ball? ______________

   ____

   E. What is the conditional probability that the ball is black given that the number on the ball is odd? ______________________

3. If event A and event B are independent and each has probability 1/4, find the probability of their intersection. ______________________

4. We have two urns. Urn I contains three white and seven black balls, and Urn II contains two black and two green balls.

   A. If we choose two balls at random from Urn I without replacement, what is the probability that they are both black? ______________

   B. If we choose two balls at random from Urn II with replacement, what is the probability that they are of different colors? ____________

   C. If we choose a ball at random from the first urn and then independently choose a ball at random from the second urn, what is the probability that neither ball is black? ____________________

D. We are going to choose two balls from the urns in the following way: Choose the first ball at random from Urn I. If this ball is white, replace it and choose the second ball at random from Urn I also. If the first ball is black, however, put it into Urn II and choose the second ball at random from Urn II. What is the probability that both balls are of the same color? ______

5. A card is drawn at random from a standard deck. What is the probability that the card is a spade or an ace? ______

6. If $P(A) = .7$, $P(B) = .2$, and $P(A|B) = .5$, find $P(A \cap B)$. ______

7. Cards are drawn at random from a standard deck until a black card appears, or until four cards have been drawn, whichever comes first. Each card is replaced before the next card is drawn, and each drawing is independent of others.

   A. List the points of the sample space. ______

   B. Assign probabilities to the elementary events. ______

   ______

   C. What is the probability that less than three cards are drawn? ______

   ______

   D. What is the conditional probability that four cards are drawn given that the first card is red. ______

   ______

8. A sample space contains 50 sample points, and the event A in the sample space contains 5 points. Find the probability of the complement of A, assuming all outcomes are equally likely. ______

9. A fair die is rolled twice. Find the probability of getting at least one six. ______

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13. ABSTRACT

Information mapping is a method of organizing categories of information and of displaying them for both learning and reference purposes. The method may be applied to the production of self-instructional books or to the organization of data bases for computer-aided instruction and reference. This report is itself written in modified information map form. The procedures and rules for information mapping were derived from educational research and technology as well as from the communications world. The emphasis is on formats to communicate quickly and to facilitate scanning and retrieval. The research and development work reported here deals with the book form of a twelve-hour course on sets and probability; significant achievement scores and favorable attitude results were found in several evaluative series with college students. Because information maps are composed of separable labelled information blocks, they can serve as the data base for computer systems where both learning and reference needs must be met. Preliminary work with simulated computer displays explored the flexibility with which a system so organized can respond with a range of user options and display variations. Cost for instruction hour is competitive with that of other methods, but the method has additional advantages in its versatility and ease of updating.

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Security Classification

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14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Information Mapping						
education						
learning						
training						
reference						
programmed instruction						
programmed learning						
computer-aided instruction						
computer-assisted instruction						
computer displays						
information retrieval						
human factors						
human engineering						

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Early Manuscript

Key Ideas Mapped

1969-1975

Information Mapping

Definition

Information Mapping is a method of bringing together current learning research and instructional technology into a comprehensive materials development and presentation technology to improve technical communication.

It includes a system of principles and procedures for:

- identifying
- categorizing
- interrelating and sequencing, and
- presenting graphically

information required for learning and reference.

Basic Purposes

The aims of Information Mapping are. . .

TO MAKE EASIER AND QUICKER

- learning and referencing
- preparation of learning/reference materials
- maintenance (updating/change) of learning/reference materials.

Comment

Information Mapping is a comprehensive technology embracing such elements as:

- a set of classification categories
- rules for writing Information Maps
- Procedures for preparing and sequencing different types of Maps
- Formats for presentation of different types of Maps
- Rationales and research on which the whole technology is based.

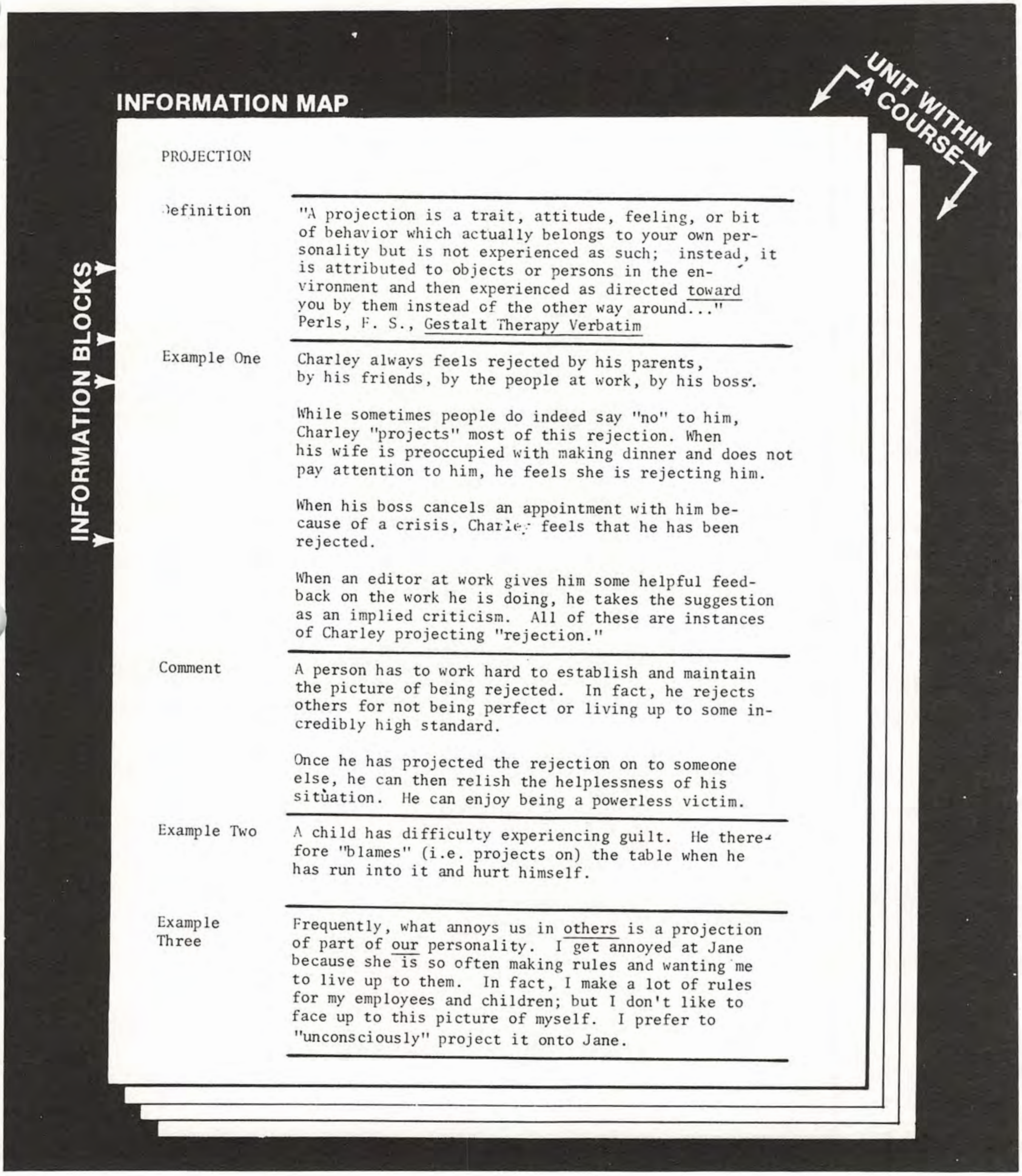
Thus, in one sense this entire book is a definition of Information Mapping.

Next Pages

The next two pages will give you examples of one kind of simple Information Map and illustrate some of the main visible features.

Actual examples of small units of use of Information Mapping in industry and colleges will be found in the Course Examples Section of this book.

Example of an Information Map



PROJECTION

Definition	"A projection is a trait, attitude, feeling, or bit of behavior which actually belongs to your own personality but is not experienced as such; instead, it is attributed to objects or persons in the environment and then experienced as directed toward you by them instead of the other way around..." Perls, F. S., Gestalt Therapy Verbatim
Example One	Charley always feels rejected by his parents, by his friends, by the people at work, by his boss. While sometimes people do indeed say "no" to him, Charley "projects" most of this rejection. When his wife is preoccupied with making dinner and does not pay attention to him, he feels she is rejecting him. When his boss cancels an appointment with him because of a crisis, Charley feels that he has been rejected. When an editor at work gives him some helpful feedback on the work he is doing, he takes the suggestion as an implied criticism. All of these are instances of Charley projecting "rejection."
Comment	A person has to work hard to establish and maintain the picture of being rejected. In fact, he rejects others for not being perfect or living up to some incredibly high standard. Once he has projected the rejection on to someone else, he can then relish the helplessness of his situation. He can enjoy being a powerless victim.
Example Two	A child has difficulty experiencing guilt. He therefore "blames" (i.e. projects on) the table when he has run into it and hurt himself.
Example Three	Frequently, what annoys us in others is a projection of part of our personality. I get annoyed at Jane because she is so often making rules and wanting me to live up to them. In fact, I make a lot of rules for my employees and children; but I don't like to face up to this picture of myself. I prefer to "unconsciously" project it onto Jane.

Related Pages	block, 5 map, 8	unit, 14 definition, 139	example, 155 comment, 147

The Main Visible Features of Information Maps Are . . .

INFORMATION IS PRESENTED IN BLOCKS

LABELS IDENTIFY KIND OF INFORMATION

CONSISTENT FORMAT FOR EACH KIND OF INFORMATION

LOCAL INDEX TO PROVIDE QUICK LOCATION OF PREREQUISITE TOPICS

EXERCISES AND FEEDBACK QUESTIONS LOCATED IN CLOSE PROXIMITY TO INFORMATION

APPEAR ON NEXT PAGE

DATA NAMES AND DATA ITEMS

Introduction

In mathematics, a formula is sometimes given as

VOLUME is equal to LENGTH x HEIGHT x WIDTH

or sometimes

V = L x H x W

These words (LENGTH, VOLUME, etc.) or symbols (V, L, etc.) correspond to the data names in COBOL. They have the same function of enabling us to refer to data with out using the exact numbers involved in a particular problem.

Definitions

A <u>Data Name</u> is a group of characters that stand for whatever values may be associated with them (data items) when the program is actually run.

<u>Data Item</u> is the numerical value associated with a data name. Because a Data Name also identifies a storage location in the computer, Data Items are sometimes referred to as 'the contents of' the Data Name.

Rules

- A Data Name may contain only
  - letters from A to Z
  - digits from 0 to 9
  - hyphens
- A Data Name may <u>not</u> contain more than 30 characters
- Hyphens may appear only in the middle of the name, <u>not</u> at the beginning <u>nor</u> at the end of the name.
- At least one character of the Data Name must be a letter.
- <u>No</u> COBOL reserved words may be used for data names.
- Blank spaces are <u>not</u> permitted within the Data Name.

Examples

VOLUME
NET-PAY
QUANTITY-NEEDED-FOR-MONTH
GRAND-TOTAL-OF-ALL-SALESMEN
S49
849-778342-99-YS-4

Non-Valid Examples

NET PAY (space not permitted)
GRAND-TOTAL- (cannot end with hyphen)
LABEL (this is a COBOL reserved word)
DATA (this is a COBOL reserved word)
3458762 (must contain at least one letter)
#3478 (# is character not permitted in data name)
GRAND-TOTAL-OF-ALL-SALESMEN-FOR-YEAR (more than 30 characters)

Related Pages

Reserved Words, 33 characters, 27

Information Blocks

Introduction	One key innovation of Information Mapping is the classification of all sentences and diagrams in a subject matter into a new unit of writing called the Information Block.
Definition	An Information Block is the smallest part of an Information Mapping analysis. A Block consists of: • one or more sentences (and/or diagrams) about a logically coherent fragment of subject matter, and • a label (which describes the function or contents of the Block, e.g. "definition" "example" etc.) A Block is always part of a Map. Blocks are easy to identify on already constructed Maps because they are separated by horizontal lines and have their labels prominently displayed in the margin (or otherwise graphically prominent place.)
Comment	There are 38 basic types of Blocks and about a dozen Map types. We will take up the most frequently used Blocks and Maps later in this book.
Exercise	Look at the example of an Information Map on page 3. How many blocks does the Map contain? _______
Answers:	*The Map contains six Information Blocks and has three types: Definition, Example and Comment. A fourth type is called a Name of Map Block. You, of course, could not be expected to guess that. The word "Projection" is the whole Name of Map Block. It is an "unlabelled" Block and has no text. It was called a Block simply to make computer retrieval simpler.*

Related Pages map, 8 block types, Chapt. 9

Types of Blocks

Introduction	All sentences and diagrams in an Information Map book are a part of Information Blocks.
Examples	Here is a partial list of the types of Information Blocks: • Definition • Diagram • Description • Introduction • Example • Non-Example • Parts • Procedure • Fact etc.
Comment	As you notice, an attempt has been made to give the Blocks labels that are "natural" to the reader and writer. There are 38 types of standard Blocks, and a few have sub-types as well; but for now you do not need to know them. You will find a complete list of the types of Blocks in the chapter called Reference Collection of Block Types. In the following chapters you will gain experience in writing different Block types.

Related Pages	types, 13 reference collection, Chapt. 9	definition, 139 diagram, 149 description, 154 procedure, 124 fact, 143	introduction, 146 example, 155 non-example, 156 parts, 144

Some Properties of Blocks

Introduction

Unlike paragraphs in ordinary books, technical manuals, etc., which are only loosely defined, and are woven together with frequently elaborate "transition" phrases and sentences, Information Blocks are standardized and modular.

Properties

1. Information Blocks of a particular type are all similar. For example, in a "Definition" Block you will find only sentences which define a specified term. No sentences or words unnecessary to the given definition appear in the Block.

2. Information Blocks are modular. Any Block or Map can be taken out, improved and replaced at any given time, with minimum effect on the rest of the Map or Book of which they may be a part.

Example

Here is an example of an Information Block with information which belongs in other Blocks edited out.

This material goes in a Definition Block.

Example ~~Mental Models are analogies. Scientific or engineering models are representations of some aspects of complex events, structures, or systems made by using symbols or objects which resemble that which is being modeled.~~ To illustrate, we use a 3-dimensional model of an airplane in a wind tunnel to study its aerodynamic properties.

Related Pages

block, 5
definition block, 139
example block, 155
map, 8

Information Maps

Definition	An Information Map is the collection of all relevant Information Blocks about a limited topic.
Comment	Just which Blocks need to be part of a given Information Map depends on the purpose of the book/course, the nature of the subject matter/job, and the characteristics of the users of the written material. It is the job of the Information Map writer to determine these.
Rule	Each Information Map has an unlabeled Block called a Map Name. For example, in a course on an office copying machine, some names of Maps might be: • The Paper Feed • How to Turn on the Machine etc. The name of the map is always displayed prominently at the top of a Map.
Classification List	There are six basic types of Maps: • <u>Structure Maps</u> (about physical things, objects which have identifiable boundaries) • <u>Procedure Maps</u> (which explain how to do something, and in what order to do it) • <u>Process Maps</u> (which explain how a process or operation works; how changes take place in time) • <u>Classification Maps</u> (which show how a set of concepts is organized) • <u>Concept Maps</u> (which define and give examples and non-examples of new aspects of the subject matter) • <u>Fact Maps</u> (which give results of observations or measurements without supporting evidence)
Comment	We will introduce each of these types of Maps in detail in a later unit. For now, all you need to know is that the different Information Blocks group themselves into different types of Maps, and that each of the types of Maps <u>looks</u> somewhat different.

Related Pages

block, 5
map name, 145
structure map, 49
procedure map, 36
process map, 77
classification map, 59
concept map, 88
fact map, 95

What Information Maps are *Not*

Example One

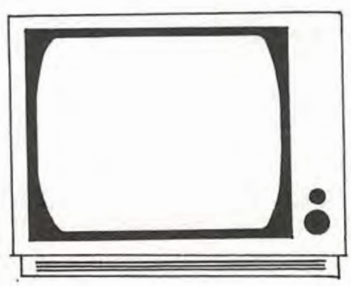
Information maps are not visual representations of physical objects.

Thus, a road sign with a cross on it to represent an intersection of roads is not an information map in the sense that we prefer to use the word.

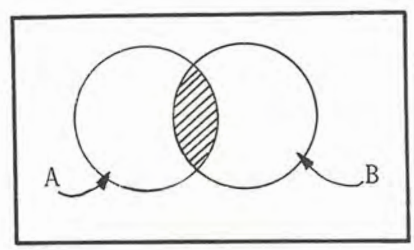
This sign is not an information map.

Example Two

A representation of a physical object in a drawing or diagram is not by itself an information map (although a diagram or drawing or photograph may be part of an information map).



This drawing is not an information map.



This Venn diagram is not an information map.

Example Three

Signs, symbols, notations by themselves are not information maps (although they may be part of an information map).

+ - X ÷ = % ? *

{ a + b } = c

♂ ♀

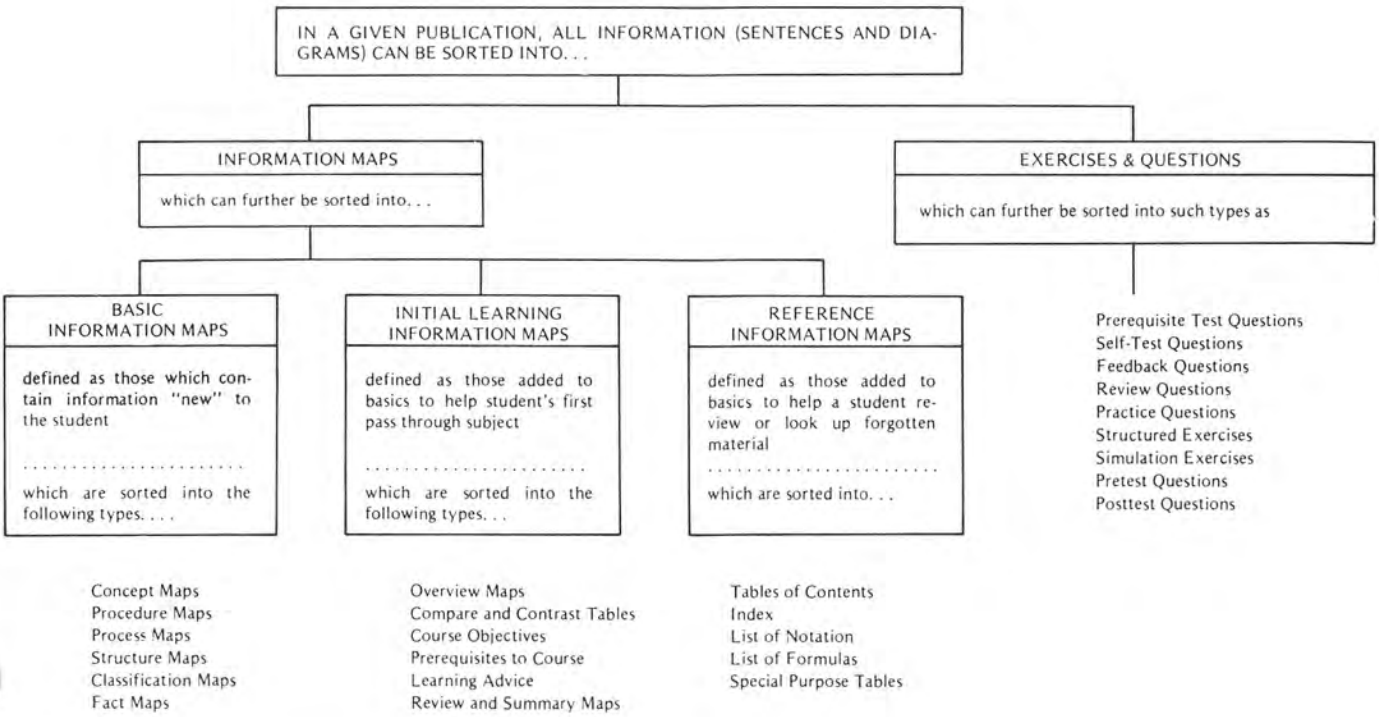
Not information maps.

Related Pages: map, 8

Rationale for the Name "Information Mapping"

Introduction	As we've already noted, Information Mapping comprises a number of procedures, formats, rules etc. including those for: • analyzing • organizing • writing • sequencing, and • displaying different types of information. The originator of Information Mapping felt that the collection of methods was unique enough to warrant a singular name to refer to the overall methodology. The problem was to pick a term which could be used for all of the different aspects mentioned above. That turned out not to be possible because one or two words simply don't connote the wide range of things indicated. So he picked the term Information Mapping, which had analagous connections to <u>some</u> aspects of the overall technology.
Description	Information Mapping, thus, refers primarily to the graphic format aspects of the subject--the more obvious visible part of the technology. The terms suggest that there is a definite structure or topography to the information we use and that "maps" which somehow resemble this structure can be devised.
Comment	Obviously some block types have stronger spacial analogues to the structure of information than others.
Example One	The same information that is contained in a paragraph comparing and contrasting something can be rearranged into a tabular format which immediately tips off the reader that similarities and differences are being discussed. The table is always used in Information Mapping and is asserted to be more "map-like" than the paragraph.
Example Two	Explaining a procedure always involves describing a set of discrete steps. In Maps these are in discrete boxes and are numbered. Often, in normal prose paragraphs, the steps are buried and unnumbered.
Related Pages	map, 8 block, 5 compare and contrast, 107 procedure, 36

Basic Types of Information Maps



NOTE: Each of the types of maps may also have several subtypes. Each of the Basic Maps has specified types of Information Blocks associated with it.

Hierarchical Nature of Mapping

Description

All Information Mapped materials are hierarchically arranged into

- Courses
- Units (sections, chapters, modules)
- Maps
- Blocks

Diagram

INFORMATION MAPPING INITIAL LEARNING AND REFERENCE MATERIALS ARE DIVIDED INTO:

COURSES → Which have the following associated with them:

- Previews
- Prerequisite Tests
- Self Tests
- Course Objectives
- List of Prerequisites
- Time it Takes Map
- Learning Advice Map
- Various Aids to Reference etc.

Which are divided into...

UNITS (SECTIONS) → Which have the following associated with them:

- Preview Maps
- Self Tests
- Review Questions
- Practice Questions
- Feedback Questions
- Review Maps

Which are divided into...

INFORMATION MAPS → Which have associated with them:

- Feedback Questions

Which are divided into...

INFORMATION BLOCKS → Which (in some applications for some purposes) may have associated with them:

- Feedback Questions

Which contain sentences and graphic material

When to Use Information Maps

Introduction	Information Mapping has been developed in answer to the demand for quicker and easier communication in all domains of life.

Criteria

1. Can be used for books or computer data bases
2. Used primarily for written learning or reference materials
3. Used when the subject/job is primarily one or more of the following:
   a. Conceptual (What is it? Generalizations, discriminations)
   b. Procedural (How to do it? In what order to do it?)
   c. Process (How does it function?)
   d. Classification (How is it organized?)
   e. Structural (What are its parts?)
   f. Decision (Which should I do?)
4. At the present time, Information Mapping is <u>not</u> used for the following types of situations:
   a. to report on some specific event that has happened (i.e. case studies, ordinary business reporting, the write-ups of scientific experiments, etc., although we have explored this latter situation to some degree)
   b. to propose or to plan some particular project or activity
   c. to argue for or against a particular thesis
   d. to simulate transactions or events (although we have begun to explore the use of Information Mapping to explain the rules of play for simulation games)
   e. to aid in the learning of a physical (psychomotor) skill (although you can use Maps to write <u>about</u> such skills)
   f. to aid live, interpersonal learning (i.e. role playing, etc.)
   g. to improve motivation in work and learning tasks (although many students have commented that Information Mapping has helped them get through subject matter that had been very discouraging to try to learn by some other method)
5. May be used for design of Audio-Visual materials.

Related Pages	computer, 309	subject/job, Chapt. 10	learning-reference, 306

Applications of Information Mapping

Introduction	Information Mapping was developed for use in that part of science, technology, and business which represents the largest amount of human information processing. It is aimed at the very center of the paperwork mountain in business and government.

Classification List	Information Mapping can be used in the following types of situations:
	
	• For <u>documentation</u> of projects
	  • computer program documentation
	  • early specification of equipment design
	  • project records
	
	• For <u>reference</u> material
	  • company procedures books
	  • technical handbooks
	  • sales reference books
	
	• For initial <u>training</u> materials
	  • technical training books
	  • operator training books
	  • maintenance training
	    etc.
	
	• For <u>computer-assisted instruction</u>
	  • course-ware, either put on computer now, or put in books now and on the computer later
	  • as a meta-language for transferring course-ware among different languages

Examples	Actual applications in government and industry to date include: company policy book, temporary typists training manual, computer program documentation, accounting procedures book, sales handbook, teachers manual, programmer training in computer industry, management planning training, and many others.
Comment	Information Mapping can be used in the academic world as well with the obvious applications in written material in the sciences, mathematics, social sciences, engineering, etc.

Related Pages: documentation, 306; reference, 306; computer-assisted instruction, 309; training, 306

The Six Basic Types of Maps

Definition

A Basic Map is one of the six types listed below which presents all of the new information presented to a student in an Information Map book.

MAP CLASS	DEFINITION
STRUCTURE	A structure is a physical thing, or something which can be divided into parts (such as a diagramming system) which have physical or identifiable boundaries
PROCEDURE	A procedure is a set of steps that a person performs to obtain a specified outcome. This includes the decisions that need to be made.
PROCESS	A process is some structure changing through time for some purpose. The description of a process involves writing about what happens during successive stages of time. (Most of the sciences are descriptions of processes.)
CLASSIFICATION	Classification is used to designate the result of the procedures where a group of specimens are sorted into classes or categories by the use of one or more sorting factors.
CONCEPT	A concept is some sequence of words and sentences in a subject matter for which we can reasonably answer the following questions: • What is its name? • What is its definition (description)? • What are examples of the concept? • What are non-instances (or non-examples) of the concept?
FACT	Facts are sentences containing associations of such things as • symbols • measurements • dates associated with events • experimental results presented without supporting evidence.

Related Pages

map, 8
structure, 49
procedure, 36
process, 77
classification, 59
concept, 88
facts, 95

Familiarizing Yourself with Blocks

Purpose

The purpose of the next sequence of activities is to acquaint you with the most frequently used Blocks.

The purpose is not for you to learn everything there is to know about Blocks, but rather, just to get acquainted.

Directions

Locate the Reference Collection of Information Blocks toward the end of this book.

Below are the names and page numbers of 12 Blocks:

Block Name	Page Number
Definition	139
Example	155
Introduction	146
Name of Map	145
Diagram	149
List	120
Use	151
Fact	143
Procedure Table	124
Stage Table	132
Description	154
Comment	147

For each Block:

1. Read the page in the Reference Collection
2. Optionally, write an example of this Block from some subject matter you know thoroughly
3. Ask a colleague to check over the Blocks you have written.

Block Names Can Often be Changed to Provide Better Communication with the Reader

Introduction

The term "Parts Table" communicates to the writer of Information Mapping. It is a shorthand term that tells him the type of block he is going to write. But the term doesn't really communicate well with the uninitiated reader. We use the principle that the reader should be given the easiest possible marginal labels. Some like "Definition" can be used as is. Other block names need to be changed to something more understandable.

What Are Some Other Block Names?

The following table presents alternative marginal labels for popular types of blocks:

"OFFICIAL" BLOCK NAME	BETTER LABELS FOR COMMUNICATION
Parts Table	What are the parts of an X?
Decision Table	Decide what to X
Flow Chart	Which X should I do?
Comment	Note, Important
Non-Example	Don't confuse this with...
Rules	Policy, Recommendations, Suggestions, Things to Watch Out For, Don't Make This Mistake, Caution
Description	How does it look? (Structure) How does it work? (Process)
Use	Purpose, Why, The Reason Why, Function
Diagram	What does an X look like?
Fact	Things to remember. Specifications
Classification List Trees, or Table	The types of X, The Kinds of X, Into what can X be sorted?
Procedure Table	The steps in
WHIF Charts, Stage Tables, State tables, other Process Blocks	How does it work? The Stages of X, The Phases of X

Summary of Basic Maps and Blocks

BLOCKS COMMON TO ALL TYPES OF BASIC MAPS

- Name of Map
- Introduction
- Comment
- Synonym
- Diagram
- Analogy
- Related Pages
- Use

BLOCKS FOR PROCEDURE MAPS

- When to Start
- When to Stop
- Procedure Table
- Flow Chart (Algorithm)
- Decision Table
- Checklist
- Worksheet

BLOCKS FOR PROCESS MAPS

- State Table
- Stage Table
- WHIF Chart
- Parts-Function Table
- Block Diagram
- PERT Chart
- Cycle Chart

BLOCK COMMON TO BOTH STRUCTURE AND PROCESS MAPS

- Description
  For Structure Maps: How does it look?
  For Process Maps: How does it work?

BLOCKS FOR STRUCTURE MAPS

- Parts (Sub-parts)

BLOCKS COMMON TO STRUCTURE AND CONCEPT MAPS

- Example
- Non-example

BLOCKS FOR CONCEPT MAPS

- Definition
- Formula
- Rules
- Theorem (Generalization)

BLOCKS FOR CLASSIFICATION MAPS

- Classification List
- Classification Tree
- Classification Table
- Outline

BLOCK FOR FACT MAPS

- Fact

A Summary of a Few Writing Rules

<table>
<tr><th>ASPECT</th><th>WRITING RULE</th></tr>
<tr><td>Series</td><td>Tabulate long series of
• words,
• phrases,
• clauses, and
• sentences of similar construction
rather than bury them in prose paragraph form.</td></tr>
<tr><td>Underscoring</td><td>Always underscore the word <u>not</u>.

Where appropriate, underscore words such as
• if • nor • either • nothing
• unless • never • except etc.

Research suggests that many errors in reading directions are made by the reader's eye missing such key words.

For the same reason, underscore words like
• refuse • lack • unable etc.
• decline • failure • belie
<u>if</u> they change the meaning of the whole sentence.

Underscore to stress significant words.</td></tr>
<tr><td>Blocks</td><td>Within a Block, avoid using words or phrases that refer to previous Maps or Blocks (e.g. "as we mentioned above," "as you have learned in the previous map," etc.).
The place to put these is in Introduction Blocks, Overview Maps, and occasionally other places.

Within a Block, many short chunks are preferable to one long paragraph. Break up the longer ones.</td></tr>
<tr><td>Numbers
Letters
Bullets</td><td>Use numbers (1, 2, 3, etc.) to sequence procedure table Blocks.

Use letters (A, B, C, etc.) to sequence state and stage tables.

Use bullets for all other types of lists.</td></tr>
<tr><td>Order of Blocks in Concept Map</td><td>Put Blocks in this order for Concept Maps:
• Name and synonyms
• Introduction
• Definition (Description)
• Formula (Diagram) (Notation)
• Examples
• Non-Examples
• Use</td></tr>
</table>

(Continued on next page)

A SUMMARY OF A FEW WRITING RULES, Continued

ASPECT	WRITING RULES
Page-Sized Maps	Where possible, start each new Map at the top of a page. Where possible, get a typewritten Map on a single page. Examine carefully Maps which run for several pages to see if they can be split into several Maps.
Display of Pages	Where possible, pages should be vertical. A reader should not have to turn the book sideways to read a diagram. Transform horizontal tables into vertical ones.

Concept Maps

Introduction

Often, psychologists will say that a person knows a concept when he can generalize within a class of things and can distinguish the members of the class from other classes. A person who knows a concept can tell members of a class from non-members. He can also often identify for purposes of definition critical attributes of class membership.

Definition

In writing Concept Maps, we will define a concept as some sequence of words and sentences in a subject matter for which we can reasonably answer the following questions:

- What is its name?
- What is the definition (description) of the concept?
- What are examples of the concept?
- What are non-instances (non-examples) of the concept?

Concept Maps are used to introduce new topics or terms.

Concept Maps contain the following Blocks:

Necessary Blocks

- Name of Map
- Definition (where not stated in the Name of Map)
- Example

Optionally Used Blocks

- Formula
- Diagram
- Use
- Theorem (generalization)
- Rules
- Analogy
- Non-example
- Introduction
- Comment
- Synonym
- Related Pages

How to Identify Concepts

Here are some hints for identifying concepts.

1. Look for:
   - new terms that aren't part of the users' regular vocabulary, whose usage is peculiar to that field or situation (technical terms)
   - important relationships between other concepts
   - important principles or rules or generalizations.

2. Look for ideas that seem to "need" an example for clarification. These may often be treated as concepts.

(continued on next page)

Fact Maps

Definitions

Facts are sentences containing associations of things such as symbols, measurements, dates associated with events, experimental results, and observations presented without supporting evidence.

Fact Maps are collections of Fact Blocks. They may contain:

Necessary Blocks

- Name of Map
- Fact Blocks

Optionally Used Blocks

- Introduction
- Synonym
- Diagram
- Use
- Comment
- Related Pages

Important

When you present large numbers of facts it is useful to classify them. Then the marginal labels become the names of the sorting factors (e.g., instead of "Fact Block" as the marginal label, you might use "Power Input," "Power Output," etc.). This is illustrated on the Fact Map on the next page.

Related Pages

fact blocks, 143
name of map, 145
introduction, 146
synonym, 148
diagram, 149
use, 151
comment, 147
related pages, 152

Chapter 8
Supplementary Maps for Aiding Reference and Initial Learning

Overview

Introduction

Authors use a variety of tools to improve the reference value of a book: indexes, tables of contents, etc. We use these also in Information Mapping.

Often, for the beginner, we need to add a preview of what is coming up, learning advice, and the like.

We have Maps for each of these types. They are called "Supplementary Maps" to distinguish them from "Basic Maps" (e.g., Concept, Procedure, Structure, etc.).

Description

The Supplementary Maps added particularly for reference are:

Since most of these are identical with their counterparts in ordinary books, we will not describe or illustrate them in detail. They are briefly described on the next page.

The Supplementary Information Maps which are added especially to aid initial learning are:

Important

You will note that these supplementary types of Maps do not have mandatory block labels. Rather, the author is free to use whatever labels he feels will communicate most to the reader.

(continued on next page)

Supplementary Maps for Aiding Reference and Initial Learning

Summaries

Introduction

One of the things we know about retention of learning is that summarizing and drawing together specific points of a piece of text can help fix the ideas in the reader's memory.

Definition

Summaries contain the important points of the unit in brief form and come after a unit.

Classification List

Summaries are of several kinds:

- Review
- Condensed Summaries

Example One *(Condensed Summary)*

CONDENSED SUMMARY OF SET THEORY

SYMBOL(S)	NAME	MEANING	VENN DIAGRAM	SEE PAGE
U	Universal Set	The set of all elements in a given study.	Shaded part is U.	14
$\emptyset$	Null Set	The set containing no elements		13
$\subset$	Subset Symbol	"...is contained in..."	Shaded part is subset.	11
P Q	Names of Sets	Any capital letters may be used to name sets, e.g. A, B, ...Z.		4
$\bar{P}$	Complement	Set of all elements in U not in P.	Shaded part is $\bar{P}$.	27
$\in$	Element Symbol	"...is an element of..."		6
$\notin$		"...is not an element of..."		6
$P \cup Q$	Union	Set of all elements in P or Q or both.	Shaded part is $P \cup Q$	30
$P \cap Q$	Intersection	Set of all elements common to P and Q.	Shaded part is $P \cap Q$.	35
$P - Q$	Difference	Set of all elements in P but not in Q.	Shaded part is P - Q.	44
$P \cap Q = \emptyset$	Disjoint Sets	Sets which have no members in common.	Shaded part is $P \cap Q$, which is empty (therefore no shading)	42

Supplementary Maps for Aiding Reference and Initial Learning

Review Maps

Definition	Review Maps are maps added to the Information Map data base specially to aid learning and reference. They summarize a unit or section of a course. They may have a non-standard set of block labels.
Status Remark	Review maps at present are treated loosely in these writing rules in order to give the writers maximum flexibility in providing useful material for the reader. Reviews are one of the places where "transitions" are possible. The writer may wish to take advantage of this opportunity.
When to Use	Reviews should be written at least at the end of every major unit.
Rule	A good rule of thumb for review frequency is: one review map every 10-30 maps, depending upon the natural clustering of concepts on the prerequisite chart.
Example	The following is review part of a review-and-preview map on probability theory.

Review

We first learned about the basic building blocks:

- The outcomes of a simple experiment are represented by sample points in a sample space.
- Each sample point is the sole member of an elementary event. These elementary events can be grouped in different ways to form events representing the classes of experimental outcomes that interest us.

Next we saw how operations with events produce new events:

- The union of events is a new event.
- The intersection of events is a new event.
- The complement of an event is a new event.

Supplementary Maps for Aiding Reference and Initial Learning

Table of Contents

Definition	The Table of Contents Map lists the name of page number of every map in a course. Tables of contents of sections and units may also be provided when the data base for the course is extensive.
Example	The following is a partial table of contents:

T A B L E   O F   C O N T E N T S

Unit 1 - Sets

Sets and Subsets

Index

Description	An alphabetical index of all of the terms and topics in the Information Mapped book should be made using a standard indexing methodology.
Comment	It has been found that Information Mapped books are particularly easy to index because of their structured construction and orderly introduction of terms.

Supplementary Maps for Aiding Reference and Initial Learning

List of Notation

Definition	The List of Notation is a special kind of summary table which gives symbols (or notation), their meaning and sometimes their pronunciation. The list can encompass symbols from a section of a course or from the entire course.
Rule	The symbols should be ordered in some manner. For example, they may be ordered: • alphabetically • in the order in which they were presented
Example	Here is an example of the headings of a list of notation:

FORMULAS USED IN THIS COURSE

SYMBOL	PRONUNCIATION	MEANING	SEE PAGE

List of Formulas

Definition	The List of Formulas is a special kind of summary table which gives the name and formula for a section or an entire book.
Rule	The formulas should be ordered in some manner. Typically they are given in alphabetical order by the name of the formula or in sequential order as they appear in the book.
Example	Here is an example of the headings of a LIST OF FORMULAS:

FORMULAS USED IN THIS BOOK

NAME	FORMULA	SEE PAGE

Related Pages

notation
block, 153

formula
block, 140

Supplementary Maps for Aiding Reference and Initial Learning

Previews

synonym: "overview"

Introduction

Some learning research suggests that learning is easier if the reader is prepared in advance for the kind of materials he is to meet. Such introductory material is sometimes placed in Introduction Blocks.

This type of "advance organizer" can also be placed in a separate map at the beginning of short groups of maps.

Definition

A Preview Map is a map added to an Information Unit specifically to aid learning. It organizes in advance the material for a unit or chapter. Other information in the various parts of the preview may include "transition" or "tying together" information.

When to Use

Previews should be written for the beginnning of each section and unit.

Example

The following is part of a preview map on probability theory:

> **Present**
>
> We have now reached the point where we need to attach probabilities to those events that are formed from other events--by event union, event intersection, and event complementation. The task is complicated by the fact that some events may overlap--as happens when any sample point belongs to more than one event. (A point representing a student in a college survey might be a member of all these events: male, senior, French major, Democrat, Baptist, tennis team, glee club, class officer, and red-haired.)
>
> **Future**
>
> The concept of conditional probability will lead us eventually to several convenient tools for evaluating probabilities in more complex situations than we have yet encountered.

Rule

The writer has wide discretion for choosing the names of blocks he wants to include for Preview Maps. There are no required blocks, making this, the most flexible of maps. Some names that writers frequently use are: Introduction, Classification List (Table, Tree), Learning Advice, Objectives. Block names may come from the subject matter itself: e.g., Problem, Solution, etc.

Supplementary Maps for Aiding Reference and Initial Learning

Compare and Contrast Maps

Introduction

Sometimes, we find from empirical tryouts of instructional material that two concepts are very similar to each other and are frequently confused. It is important to aid the learner in making a discrimination between the concepts. This can be done in two ways:

- with a compare and contrast table
- with feedback questions that accompany a compare and contrast table.

Definition

A Compare and Contrast Map is a special Information Map which contains no new information, but which juxtaposes similar types of information about the concepts.

When to Use

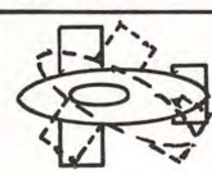
Use a compare and contrast table whenever there is evidence that a difficulty of learning may be occurring because of a confusion between two similar things.

Example One

In the study of set theory, the student frequently confuses union and intersection, so a compare and contrast table was made, which compared definition, diagram, and examples.

Example Two

Here is an example of a compare and contrast table with three concepts:

COMPARING...	YAW...	PITCH...AND...	ROLL
Definition	The rotation of an aircraft or space vehicle about its vertical axis. (Turning right or left.)	The rotation of an aircraft or space vehicle about its transverse axis (Nosing up or down.)	The rotation of an aircraft or space vehicle about its longitudinal axis. (Side to side rocking.)
Diagram			

Comment

Multiple choice questions are usually the most appropriate methods of evaluating whether the discrimination learning of a compare and contrast map has taken place.

Supplementary Maps for Aiding Reference and Initial Learning

List of Course Objectives

Definition

The List of Course Objectives is a list of objectives which answers the questions:

- what will I be expected to do at the end of this course?
- under what conditions?
- with what help?
- to meet what kind of criteria?

Rule

- A list of objectives must be written for each course.
- Criteria for writing objectives such as those in Robert Mager's Preparing Instructional Objectives (Belmont, Ca., Fearon, 1962) apply.
- The objectives will be organized by unit and will be related to final exam questions.

Example One

COURSE OBJECTIVES

At the completion of this unit, the student will be able to:

- identify sets and their elements, and ways of specifying them
- identify the following:
  - universal sets
  - subsets
  - null sets
  - disjoint sets
  - complement of a set
- compute the number of subsets in any set
- identify the elements in sets formed by the operations
  - union
  - intersection
  - difference

Comment

You may wish to divide the objectives by units and place them in an Objectives Block on a Preview page.

Supplementary Maps for Aiding Reference and Initial Learning

Learning Advice Map (or Block)

Description

The Learning Advice Map contains information that the course designer believes may help the learner. It might include suggestions about:

- how to start the course
- what to pay particular attention to in the course
- the kinds of mistakes or oversights others have made in taking the course
- the optimal amount of time to spend with the course in a session
- the optimal time between study sessions.

Example

In a course on typing in the basic map format, this learning advice block was given:

Learning Advice	• Read the Checklist of Important Things to Remember When Typing. Read it again before you start typing. • Read through the rest of the material. Ask questions if you do not understand what is being said. • Answer the posttest questions. Give your response to whoever is supervising you. • If you have any questions write them down on the sheet provided and get answers from whoever is supervising you.

Comment

Learning advice maps are most frequently put at the beginning of a course, but they may be added at any point. Frequently in overviews at the beginnings of sections, a learning advice map or a block called "learning advice" is useful.

Supplementary Maps for Aiding Reference and Initial Learning

Prerequisites to Course

Definition	The Prerequisites to Course Map provides an answer to the following questions: • What do I have to know in order to learn this course? • What do I have to be able to do to learn the course? • What are the prerequisites for this course? The answers to these questions will be provided in either list or chart format.

Prerequisite Test

Introduction	To determine whether or not a student is qualified to take a course, he may be given a prerequisite test.
Definition	A Prerequisite Test will cover all of the significant prerequisite information needed by learners for successful study of a course.
Comment	Note the pretest refers to material within the course and the prerequisite test refers to material learner should know before taking the course.
Example	In a course on sets, a prerequisite test was given on the learner's "numerical ability". The following are the first few questions on a time limited test: 1. 6 2/3 + 4 1/6 = a. 5 b. 65/12 c. 10 1/3 d. 10 5/6 2. 1/3 - 1/5 = a. 1/4 b. 1/8 c. 1/15 d. 2/15

Supplementary Maps for Aiding Reference and Initial Learning

Pretest for Each Unit and Course

Introduction	Often a learner knows some of the material in a course but not all. The pretest is used to determine whether it is necessary for the learner to begin at the beginning or skip.
Definition	The pretest is a test given at the beginning of a unit. It contains questions which sample all major ideas in the unit. If the user passes the unit pretest at a pre-designated level, he may choose to take a different or more advanced course or unit. If the user fails the pretest, however, the results of the pretest may be used in determining which sections of material the user may skip and which he needs to see.

Posttest for Each Unit and Course

Introduction	When a learner completes a unit, it may be necessary to know if he has understood the material well enough to proceed to the next unit or course.
Definition	A posttest is a test which is given when the learner has completed a unit or course. It consists of questions which sample the major ideas in the unit.

Self Test

Definition	A self-test is a pretest or posttest used in printed materials, which is administered by the learner. A self test enables the learner to determine how well he knows a particular chunk of material in a course.

Chapter 9 Reference Collection of Information Blocks

Overview

Introduction	The purpose of this chapter is to provide you with an easy-to-use reference for different kinds of Information Blocks. The different blocks are arranged by the types of Maps they are frequently a part of. An alphabetical index of all the blocks is also provided.
Objectives	After looking through this unit, you should be able to recognize examples of the different kinds of blocks by consulting and comparing them with examples given.
Learning Advice	It is best not to try to learn all of these at once. In fact, we do not even recommend scanning all of them at once. Rather, read over the blocks and their rules as needed. And use this chapter as a kind of resource for suggestions of types of blocks you might find useful. Remember that Information Mapping is a flexible, modular system. If you find yourself using a new kind of block frequently, we suggest that you just add it to the list in this book.
Comment	Remember that the blocks contained in this book are specifically those blocks that are contained in Basic Maps, not in Supplementary Maps added to the basic maps for learning and reference.

Related Pages

information block, 5
alphabetical index, 117
adding blocks and maps, Chapter 16
basic maps, Chapters 2-7
supplementary maps, chapter 8

Table of Contents

Alphabetical Index of Blocks

Reference Collection

Map Classification Chart

Types of Maps	Description	Information Blocks
Concepts	A concept may be a: • technical term • generalization sentence • property sentence • rule sentence • relationship sentence	name of map introduction definition or description theorem (or generalization) formula use rule example non-example synonym notation diagram comment analogy related maps
Structures	A structure is • a physical thing, or • something which can be divided into parts which have boundaries	name of map introduction parts and subparts related maps
Processes	A process is some structure changing through time. The description of a process involves writing about what happens during successive stages of time.	name of map introduction stage table parts-function table cycle chart block diagram PERT chart WHIF chart state table related map

continued on next page

Reference Collection

MAP CLASSIFICATION CHART, continued

Types of Maps	Description	Information Blocks
Procedures	A procedure is a set of steps performed to obtain some specified outcome.	name of map introduction procedure table flowchart when to start when to stop decision table check list work sheet related pages
Classifi-cations	Classification is the sorting of things by concepts into categor-ies by the use of one or more sorting factors (criteria).	name of map introduction classification table classification sheet classification list outline related pages
Facts	Facts are sentences about things done, things that are or were in existence, events, conditions, and so one, and are presented without supporting evidence.	fact block

Classification List Block

Introduction

Classification is one of the most common activities of the human mind. We frequently find sentences of the form:

- A Widget can be sorted into 5 types.
- There are seven kinds of Widget-winders.

These types of statements indicate that classification has been done.

When people talk about the differences and similarities of things, they are talking about the attributes or factors which are used in classifying things.

Definition

A Classification List Block is a sentence (or more) showing how we have classified a group of things (or specimens). It gives a list of the things sorted and often gives the basis on which they have been sorted. The list is displayed vertically on the page with bullets (•) to facilitate easy scanning.

Example One

Types There are three kinds of cash value:

- present cash value
- cash surrender value
- audit value

Example Two

Types There are four basic types of work:

- Cleaning and grubbing
- Stripping
- Grading
- Pushing-loading

Classification List

Here are some factors by which lists may be ordered:

- known to unknown
- simple to complex
- specific to general
- general to specific
- least important to most important
- concrete to abstract
- numerical order
- alphabetical order
- chronological
- frequency

  etc.

Classification Tree synonym: "Organization Chart"

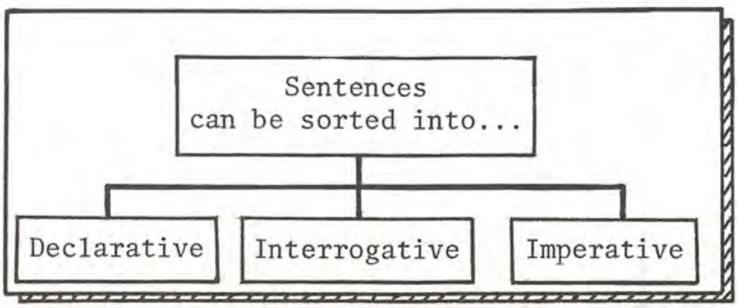
Introduction

Among the most frequent things people talk about are the differences and similarities of things. When we divide (or sort) things into different kinds of categories, we do so on the basis of similarities and differences.

Definition

A classification tree is a graphic way of showing how we have organized or classified a group of things (or specimens). It gives a list of the things sorted and shows into what classes they have been sorted. Frequently, the basis on which the sorting has been done (the similarity or difference) is also shown. The basic relationship shown by a tree, then, is how the listed specimens are related by similarities or differences used as sorting rules.

Example



WHAT ARE THE PARTS OF A TREE?

PARTS OF TREES	DESCRIPTION	EXAMPLES
Nodes ("Specimens" or "classes")	The nodes at each level show the things (or kind of things which can be grouped together by similarities and difference)	These nodes • Sentences • Declarative • Interrogative • Imperative are all classes.
Lines connecting boxes	The lines show how the things are separated or divided into groups.	
Sorting factors	The sorting factors indicate the basis on which each sort (or division) has been made. (sometimes omitted)	The sorting factor in the example is not listed. It is "purpose of sentence."

Classification Table

Introduction

When sorting things according to their similarities and differences, it is often necessary to sort according to more than one factor.

Definition

A classification table is a table which shows how a group of things has been organized or classified. In a classification table, the classification is usually made according to two classification rules or sorting factors, that is, according to two factors which indicate similarity or difference among the things which are classified.

Example

Error Type	Most Probable Source	Location on Form A79X5 (Line No.)
Misspelled Name	Input typist	14A
Missing Name	Salesman	14A
Wrong Address	Salesman did not check	15
Person Not There	Business moved	16

Note: Each item along the horizontal is similar in that they are all connected with one error type re differences to which the element of information is given.

Outline

Definition

A conventional outline is a method of organizing classified information into a hierarchy.

You often use letters and numbers as labels and indentations to assist scanning of the information.

Example

```
I.  Types of Faults in the System
    A.  Optical Faults
        1.  Dirty lenses
        2.  Maladjusted mirrors
    B.  Mechanical Faults
        1.  Paper feed
        2.  Carrier system
        3.  Print mechanism
    C.  Electrical Faults
        1.  Current overload
        2.  Faulty wiring
    D.  Use Faults
        1.  Didn't plug it in
        2.  Pushed wrong button
        3.  Didn't heed warning lights
```

Procedure Table Block

Synonym: How to Do It Block

Definition

A Procedure Block lists a set of steps that a person performs to obtain a specified outcome. It includes the decisions he has to make and the actions he must perform.

Example One

Here is a simple Procedure Block for telling a temporary employee how to open, sort and distribute the morning mail.

STEP	PROCEDURE
1	Go to the mail room after 10 a.m. and ask for the Order Department Mail. (Mail Room is located in room 1593)
2	Open all of the mail except those marked personal.
3	Sort the mail into these piles: a. Bills to be Paid. b. Book Orders. c. Inquiries about our products. d. Advertising. e. Letters addressed to particular people f. Letters addressed to Department
4	Give piles a. and b. to Mrs. James
5	Give pile c. to Mr. Elliot.
6	Throw away the Advertising.
7	Give pile f. to Mr. Gould.
8	Distribute pile e. to people concerned.

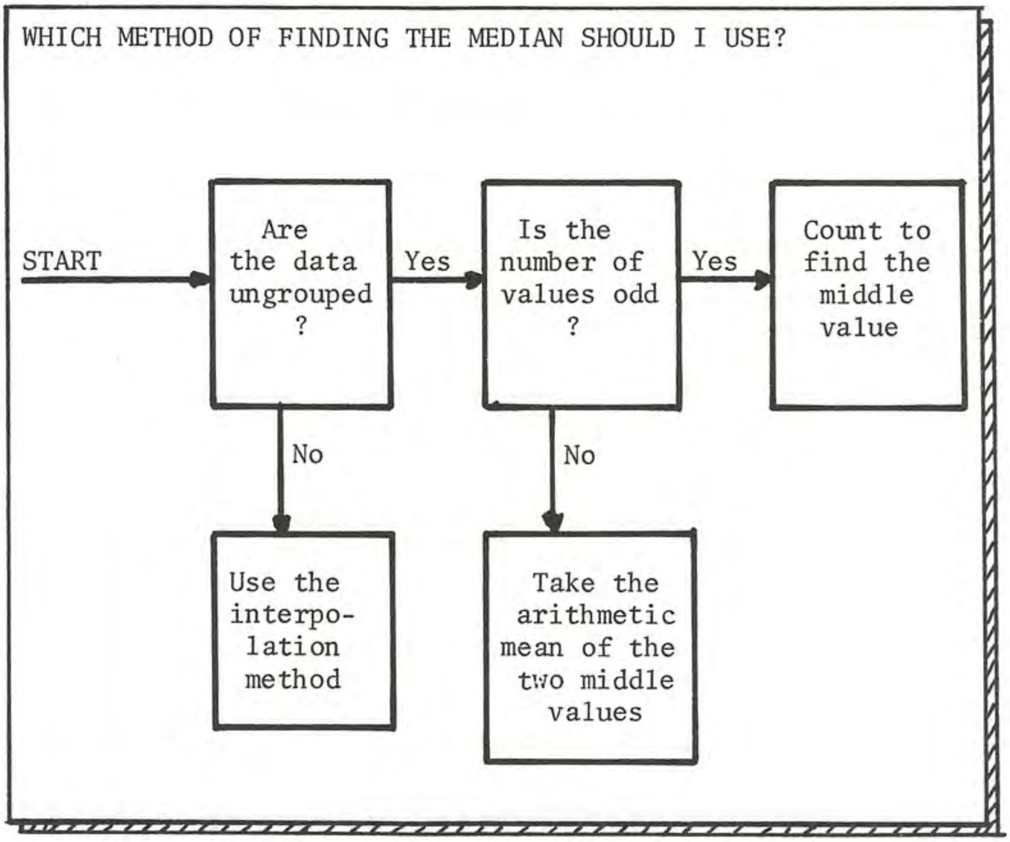
Flow Chart Block

synonym: "flow diagram", "algorithm" (in U.K.)

Definition

A flow chart is a kind of sequence network which shows graphically the order in which the steps and decisions in a procedure are to be done. A flow chart is also used occasionally to show the steps of a process.

Example



Related Pages

Making Flow Charts, Chapt. 13

Decision Table

synonym: "decision logic table"

Definition

A decision table is a method of arranging "if-then" relationships in tabular format. One part describes the circumstance or conditions that exist, and the other side describes the action the reader must take for each set of circumstances.

Example of the Basic Structure

	Conditions "If"	Actions "Then"
1		
2		
3		
4		
5		

Example One

If the data are...	Then...
ungrouped and if the number of values is odd	locate the median by finding the middle value.
ungrouped and the number of values is even	the median is found by taking the arithmetic mean of the two middle values.
grouped	the median is found by interpolation.

Example Two

If...	Then check...
there are no units coming out of the output	• registration points • all turns in conveyor subsystem.
only one unit comes out of the machine at a time instead of two	• turns on conveyor • gates after insertion point.
units are jumping the conveyor	• entire conveyor subsystem starting from output.

Related Pages

Making Decision Tables, Chapt. 14

Example of a Decision Table Block

CAPITALIZATION AND TYPE FACE

<table>
<tr><th></th><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th></tr>
<tr><th></th><th>If entry is</th><th>and it is located in</th><th>then type face will be</th><th>and capitalization will be</th><th>for example GO TO table</th></tr>
<tr><td>1</td><td>number, table name, column alpha, rule and/or acronym</td><td>table or column header</td><td>8 point roman bold</td><td rowspan="2">all caps</td><td rowspan="2">4-3</td></tr>
<tr><td>2</td><td>number or acronym</td><td>body</td><td>8 point roman</td></tr>
<tr><td>3</td><td>in column A, condition stub</td><td rowspan="2">column header</td><td rowspan="2">8 point roman bold</td><td rowspan="2">initial cap first world only</td><td rowspan="2">4-3</td></tr>
<tr><td>4</td><td rowspan="2">proper noun</td></tr>
<tr><td>5</td><td>body</td><td>8 point roman</td><td>initial cap</td><td>4-3</td></tr>
<tr><td>6</td><td>GO TO</td><td>column header</td><td>8 point roman bold</td><td rowspan="2">all caps</td><td rowspan="2">4-3</td></tr>
<tr><td>7</td><td>instruction</td><td>body</td><td>8 point roman</td></tr>
<tr><td>8</td><td rowspan="2">other narrative</td><td>column header</td><td>8 point roman bold</td><td rowspan="2">none</td><td rowspan="2">4-3</td></tr>
<tr><td>9</td><td>body</td><td>8 point roman</td></tr>
<tr><td>10</td><td>ruled line segregating quadrants of a table</td><td></td><td>2 point rule</td><td rowspan="2"></td><td rowspan="2">4-3</td></tr>
<tr><td>11</td><td>all other ruled lines</td><td></td><td>hairline rule</td></tr>
<tr><td>12</td><td>notes</td><td>below table</td><td>8 point roman when space permits; otherwise, 6 point roman</td><td>as in regular text</td><td>4-4</td></tr>
</table>

* Air Force, Department of, The Decision Logic Table Technique, Washington, D. C., 1965, p. 24.

Checklist

Introduction	A checklist is a job aid device which is used to remind a person of tasks which have to be performed and frequently the order in which these tasks are to be performed.
Definition	A checklist is a set of steps which call upon the user to notice aspects of the environment and to perform a set of steps. Usually the noticing and the set of steps has to do with objects or processes.
Comment	A checklist is much like a procedure table except that it provides space to check whether or not something has been done.

(Continued on next page)

Example of a Checklist Format*

CHECKLIST

TITLE

HAZARD DETECTION AND WARNING SYSTEM

PURPOSE

This checklist is to be used in reviewing the design and installation of facility hazard warning and detection systems.

INSTRUCTIONS ON USE

In using this checklist:

- Read the numbered item.
- Mark the checklist if the numbered item has been accomplished, considered, or is not applicable.
- Review the design for all items not marked, accomplished, or considered.

This checklist is divided into the following subject areas:

INDEX

A – General Considerations
B – Fire and Overheat Detection
C – Combustible Vapor Detection
D – Toxic Vapor Detectors
E – . . . .

INCLUDE APPLICABLE REFERENCES

SEQUENCE CHECKLIST ITEMS BY IMPORTANCE, LOCATION, ETC

PROVIDE A CHECK COLUMN

A – GENERAL CONSIDERATIONS

YES	NO	N/A		
			1. Identify all hazardous areas	AFM 00
			2. Provide hazard detection systems for all hazardous areas	MIL–D–000
			3. Use redundant detection systems for extreme hazardous areas	
			4. Provide portable sensors for use in areas where it is not practical to install fixed sensors	
			5. –	

B – FIRE AND OVERHEAT DETECTION

			6. Use overheat detectors in all major equipment installations	
			7. Install the thermal sensing devices in locations where they will operate promptly in presence of fire or heat	
			8. Do not use rate-of-rise devices in locations where the minimal environmental temperature variations exceed 15 to 20 per minute	DH 1–6, DN 4G3–6
			9. –	
			10. –	

NUMBER CHECKLIST ITEMS CONSECUTIVELY

INFORMATION GROUPED BY SUBJECT, LOCATION, FUNCTION, ETC.

C – COMBUSTIBLE VAPOR DETECTION

			11. Use combustible vapor detection in areas where combustible vapor may accumulate	AFM 000, Para 6.1
			12. Ensure that CVD's trigger an audible alarm when vapor concentrations exceed 25% of the lower flammability limit	
			13. Provide flame arrestors on all filament chambers of catalytic combustion detectors to prevent the possibility of flashback	Ref 000

D – TOXIC VAPOR DETECTION

			14. Ensure that the detector is compatible with the gases and vapors	
			15. Choose a detector that sensors specific gases rather than a general class of gases	
			16. –	

* McIntire, Gary B., Simplified Methods for Communicating Information, A.F. Systems Command, Wright Patterson AFB, Ohio, Tech. Report ASD-TR-68-45, p. 27

Worksheet

Definition

A <u>worksheet</u> is a type of procedural job-aid device which is used to remind a person of the steps to be taken (usually in a long symbolic procedure--often a decision making procedure).

The worksheet provides space for filling in relevant data and for making the calculations necessary to come to decisions.

Comment

Worksheets are procedural guides and hence are classified under procedures.

Example

OFFICE SUPPLIES

Typewriter Ribbons: IBM (call and order)
Postage Meter Tape: Friden (call and order)
Office Supplies: Bob Slate (call and order)
Graphics: Fred Stone/Charrette (call and order)
Hardware: Dickson (call and order)
Stadium (one block north)
Household Supplies: Evergood (across street)

ITEM	STOCK LEVEL	ON HAND	ORDERED	TOTAL	DATE
Typ. Ribbons:					
fabric IBM	6				
IBM film	4 box				
Camb. typ. carbon	12				
Friden Tape (6/pkg)	1 pkg				
Coffee (Chase & Sanborn)	3				
Coffee Mate	2				
Sugar packets	2 pkg				
Coffee filters (Tricol)	1 box				
Paper towels	6				
Toilet paper	12				
Soap	4				
Detergent	1				
Sponges	1				
Tissues	2				
Plastic garbage bags	6				
100 w light bulbs	8				
75 w light bulbs	8				
Fuses: T20A Fusetron	1 box				
Non-tamp 15A Type S	2 box				

When to Start Block

Description	The When to Start Block describes the situation upon which it is appropriate to begin doing a particular procedure. It describes the precise conditions so there can be no doubt in the user's mind when to start using the procedure.
Example	In a computer room, there are various kinds of maintenance routines or programs which are used to diagnose mechanical or electronic faults in the machine. Procedure maps can be written for the use of each of the types of programs. At the beginning of each type of procedure for diagnostic routine would be a "When to Start" Block.

When to Stop Block

Description	This block describes the conditions when it is appropriate to stop using a particular procedure map, decision table, flow chart.
Example One	In a computer program designed by using decision tables, a "When to Stop" block was written for each decision table.
Example Two	When to Stop When all of the correspondence has been marked, you are finished with this procedure. You should then go to procedure 19 for the next steps.

Stage Table

Introduction

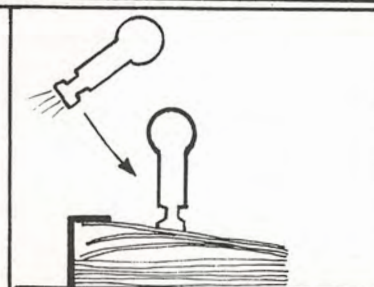
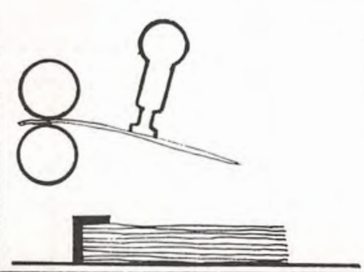
Processes have to do with change.. One of the ways of describing change is to divide the process into stages.

Definition

A stage table is a table which describes the changes being made in a structure during specific successive time periods.

The table is divided into time durations which may vary from a fraction of a second to centuries. The sentences (or illustrations) in each segment tell what the nature of the changes in the time structure are that take place during that period of time

Example One

Stage		
A	When released, the sniffers drop onto the top of the paper stack. Their ends are sealed and a vacuum is created in the tubes.	
B	The vacuum holds the top sheet of paper firmly. As the sniffers rise, the top sheet flips out from under the snubbers.	
C	The paper is fed into the paper transports.	

Rule

Use the letters "A, B, C, etc." to identify the stages. (Note: Numbers are used in procedures.)

State Table

Synonym: "Operation Table"

Introduction

Process has to do with change. One of the ways of describing structures changing is to describe successive discrete states.

Definition

A state table describes the structure at given time instants. The focus of the table is not on the changes made in the structure during a given time period but on the description of the state of the structure itself at a specified time. The successive states in the table are sequential.

Diagram

	Time 1 (or state 1)	Time 2 (or state 2)	Time 3 (or state 3)...
Name of State			
Structure or part of structure involved at this time		The cells contain	
Condition (or state) of structure or part at this time		the descriptions of the states of each of the parts of the structure	
Structure		at particular times.	
Condition (or state)			

Example One

Operation Table

Condition	Action	Result [1]	Result [2]	Result [3]	Outcome
Battery connected	Current flow to control box	Circuit number 5 "hot"	Circuit number 8 ground		[1 & 2] Control box activated
Seat switch closed	Current flow to control box	Circuit number 1-3 "hot"	Circuit number 9-10 ground	Circuit number 7 ground	[1 & 2] Set up for no start condition
Ignition switch on	Current flow to control box	Circuit number 6 "hot"	Circuit number 11 "hot"	Circuit number 12 ground	[1] Vehicle will not start. Interlock relay grounded. [2] In-gear warning circuit on
Belt switch opened	Ground circuit opened	Circuit number 2-4 open	Circuit number 11 open	Circuit number 7 partial ground ground	[1 & 2] In-gear warning circuit of; vehicle set up for start condition [3] Vehicle will start
Ignition	Engine starts	Circuit number 12 open			[1] Three-minute timer activated

Courtesy of Datsun Motor Corp., *Introduction to Ignition Interlock System 210*, 1974.

WHIF Chart

Synonym: "When and If Chart"

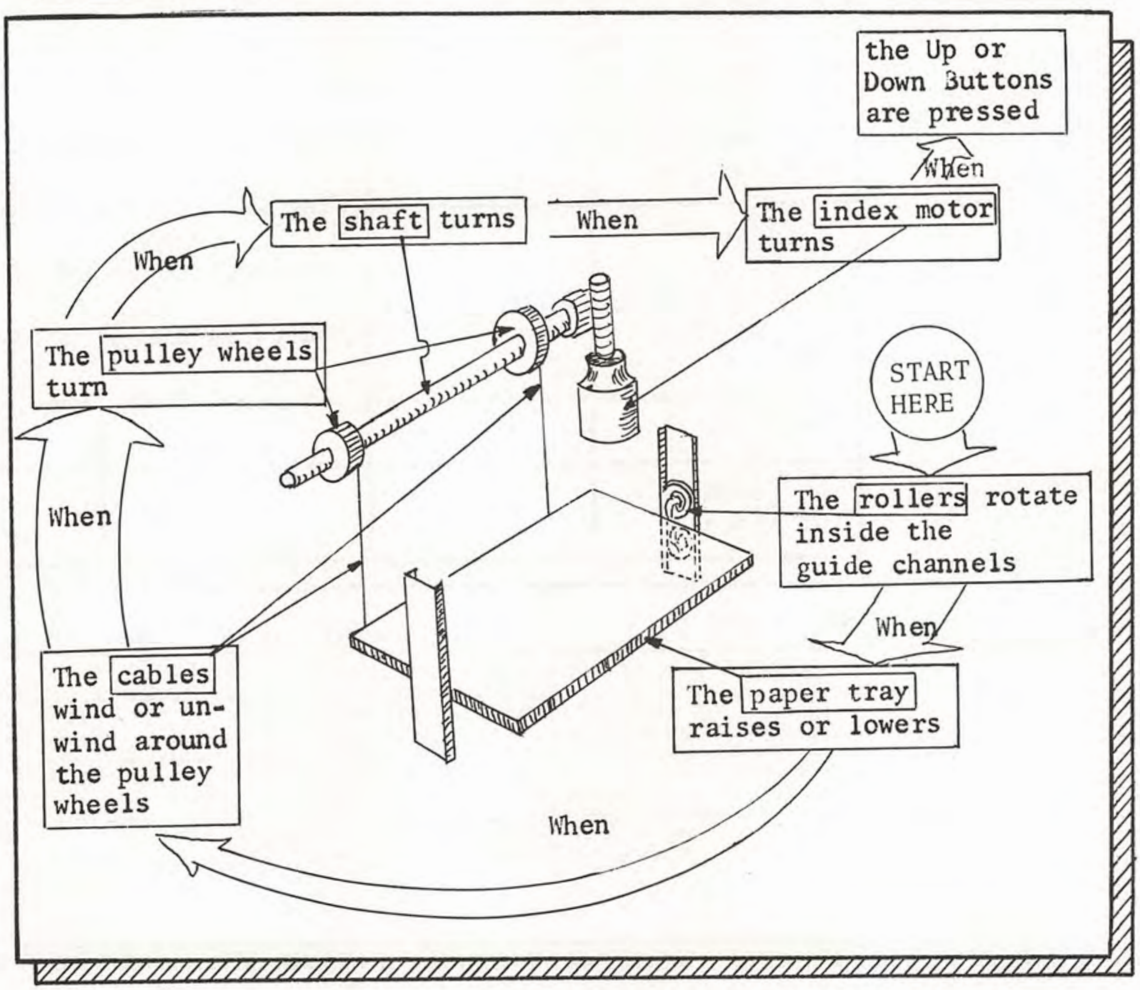
Definition

A WHIF Chart is a way of presenting how a process works by

- a diagram or illustration of the structure, and
- a sequence of descriptions of what is happening to a given part of the structure.

The entire causal sequence of the WHIF chart is presented in the grammar of "This happens when (or if) this happens." This grammar is particularly suitable to show the operations of machines, particularly the subassemblies which function simultaneously (as distinguished from those machine operations which happen one after another).

Example



Comment

Some users initially find the grammar of the WHIF Chart a bit strange, in that it seems to be "backwards." However, after reading a few of them, users seem to get used to reading that way; and, of course, writing with the "when or if" grammar is much less clumsy than the same information written "forward."

Parts-Function Table

Introduction

An author may wish to give the function of a part of a structure rather than or in addition to its description. A parts-function table is used.

Definition

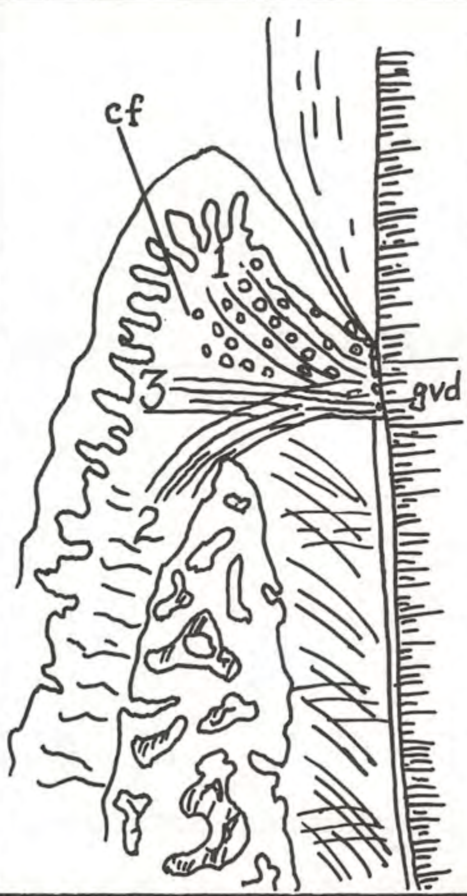
A parts-function table is a parallel table which lists the parts of a structure and their function. A parts-function table may also contain a description of the parts or comment on them.

Diagram

PART NAME	FUNCTION OF PART	DIAGRAM OF PART

Example

GROUPS OF GINGIVAL FIBERS

DIAGRAM	NAME AND SYMBOL	COURSE OF THE FIBERS	FUNCTION
	Gingivo-dental (gvd) 1. 2. 3.	Embedded in the cementum on coronal portion of root 1. fan out toward gingival crest 2. extend to periosteum of labial and lingual alveolar bone 3. end in attached gingiva	Brace the marginal gingiva firmly against the tooth to yield necessary rigidity for marginal gingiva to with-stand deflection from tooth surface in mastication.
	Circumfer-ferential (cf)	Pass through the connective tissue...	

Mulvihill, J. E., *An Introduction to Periodontology*, (unpublished, 1967).

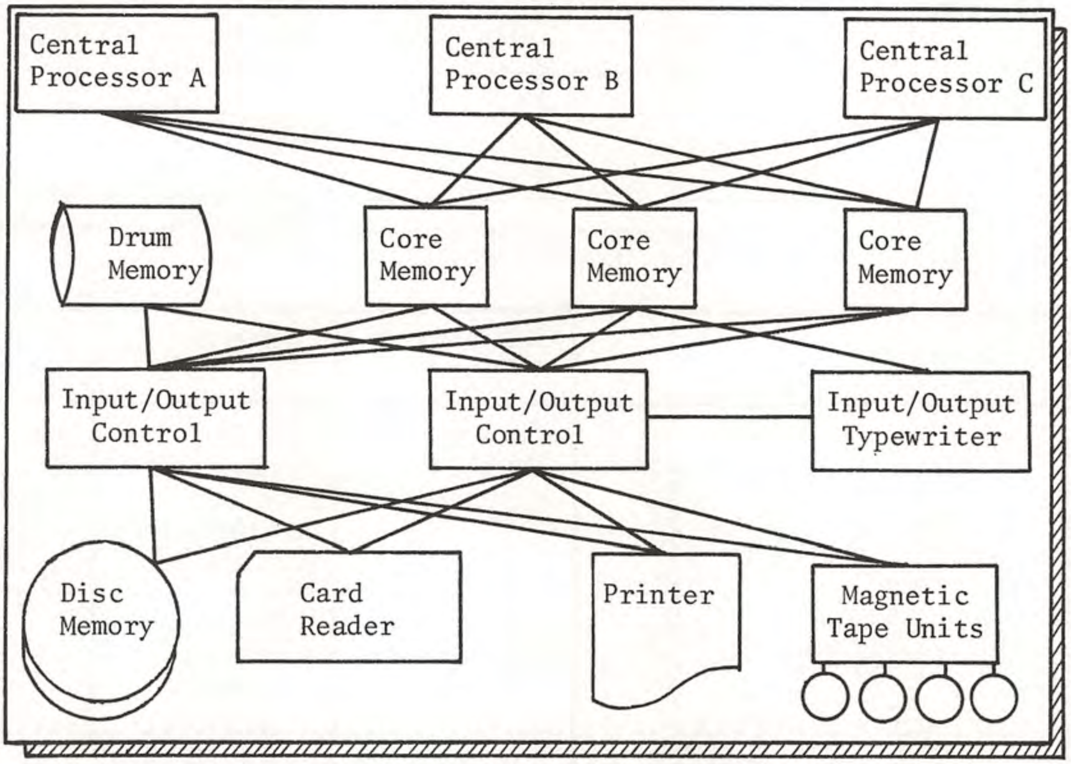
Block Diagram

Definition

A block diagram is a graphic method of representing the hardware of a given system (including a data processing system). The primary purpose of a block diagram is to indicate the paths along which information and/or control flows between the various parts of the system.

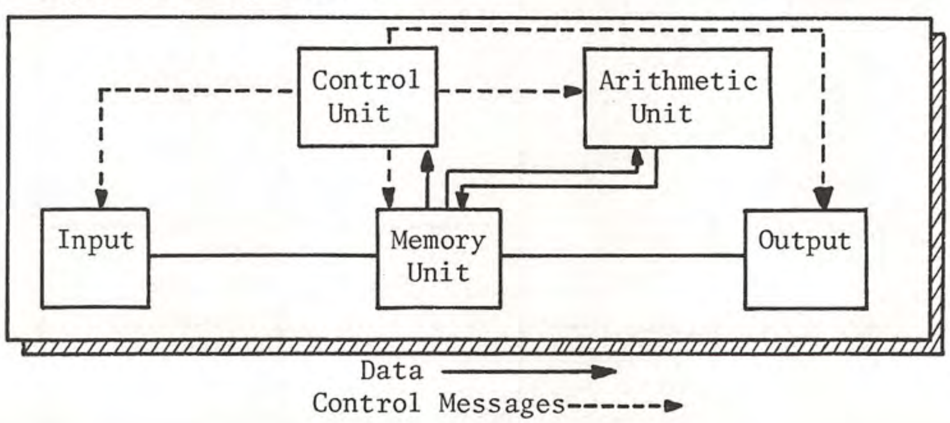
Example One

This example shows how the different parts of one data processing system are connected. The lines show that information can flow both ways between the units connected.



Example Two

This example shows how the different kinds of information are transmitted between different parts of the central processor and the input and output units.



Definition Block

Introduction	Whenever we introduce a new word or term that we feel our readers will not know or know well, we use a definition block.
Definition	The Definition Block defines or describes the concept being introduced. The author should use his knowledge of the subject matter and of his readers to determine the level of detail, sophistication, and formality to use in writing Definition Blocks.
Rules	• Every map that introduces a new unfamiliar term must have a Definition Block. • The term or phrase being defined is always underlined.
Comment	Definitions have been written in a variety of styles, from very formal dictionary and mathematical definitions to loose, informal ones. The writer should choose the level of definition and keep it consistent within the book he is writing so that the learner can expect the type of definition he will be getting.
Example One	Here is an example from a life insurance unit: Definition — Cash value is the amount of money a life insurance policy is worth at a specified time.

Formula Block

Introduction

Certain maps may deal with mathematical or scientific facts, rules or principles which can be expressed not only verbally but in symbolic form as well.

Definition

The Formula block restates a definition, theorem, or generalization in symbolic form using algebraic or other symbolic expressions.

Rules

- All formulas are first written in symbols and then followed by the words directly underneath the symbols, using braces to indicate relationship.
- Notation used in a Formula block should be explained in a Notation block before the user gets to this block.

Example One

The following are the Theorem and Formula blocks for the General Addition Laws in probability:

Theorem	The probability of the event A ∪ B is obtained by adding the probability of A to the probability of B and subtracting from that total the probability of the intersection, A ∩ B.						
Formula	$P(A \cup B)$	=	$P(A)$	+	$P(B)$	-	$P(A \cap B)$
	(Probability of the union of A and B)	=	(probability of A)	+	(probability of B)	-	(probability of the intersection of A and B)

PERT Chart

Synonym: "CPM Chart," "Network Analysis"

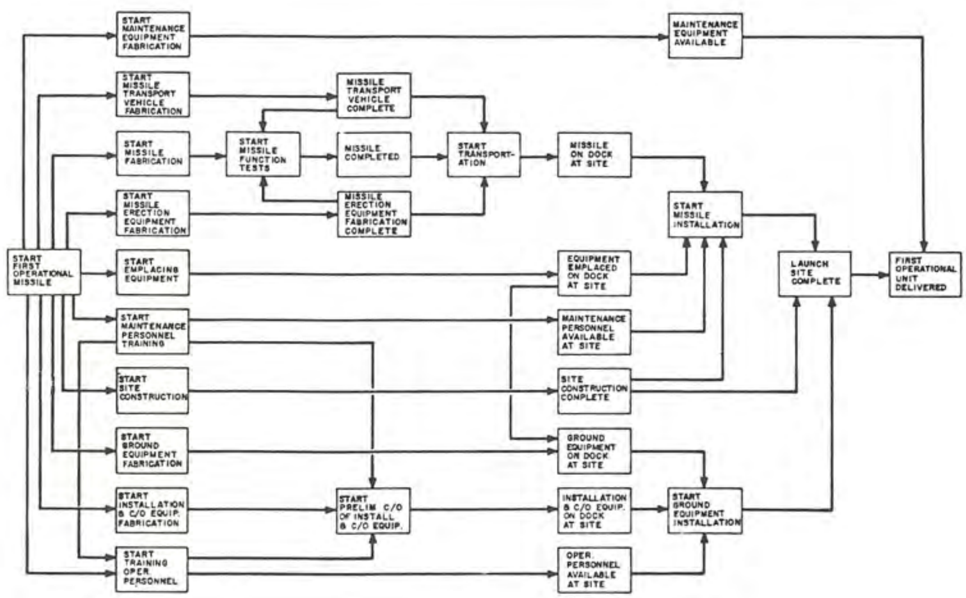
Introduction

Often, we can analyze a problem into a series of tasks to be performed. Tasks may be related as to whether or not they must be performed before, after, or during the time period that another task must be performed. For example, in planning a business project, a product must be produced before it can be delivered.

Definition

A pert chart is a kind of sequence network which shows participants or project staff which events in a project must have been completed before another given activity can start. It is used in the management of larger, one-of-a-kind projects.

Diagram



Parts Table

PART	DESCRIPTION
What do the boxes represent?	Boxes represent events (which occupy no time). The events usually indicate either the beginning of an activity or the completion of an activity.
Note	No cycles are permitted.

Comment

PERT stands for Program Evaluation Review Technique.

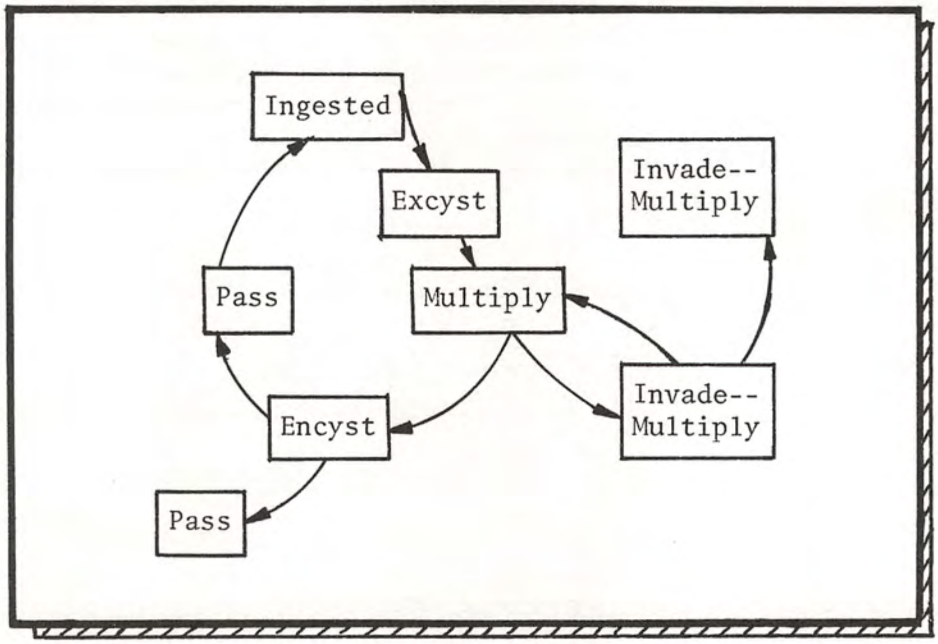
Cycle Chart

Definition

A cycle chart is a kind of sequence network that shows repetitive events or steps that a person or process goes through. It is cyclical in that after one or more events or steps the arrows lead you back to the starting place.

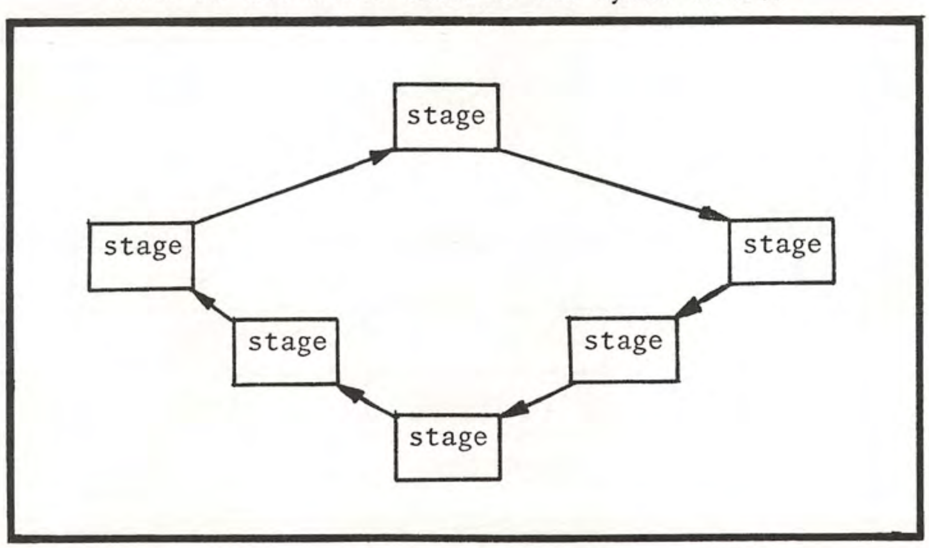
Example One

Life Cycle of the Entamoeba histolytica.*



Here is the basic form of the cycle chart.

Example Two



* Communicable Disease Center, U.S. Public Health Service, Amebiasis: Laboratory Diagnosis, Washington, D.C., U.S. Government Printing Office, 1964, Part 1, page 8.

Rule Block

Introduction	Some sentences tell people what to do. They are called rules, in the Information Mapping system. Rules can also tell you what not to do.
Definition	The Rule Block contains sentences, in the form of commands, which are used to give the reader indications of what and what not to do.
Use	Rule Blocks may be written to cover errors that are commonly made. They may also be used for advice and hints.
Comment	A rule may also be a Map Name, if the author thinks the intended population requires an example to understand it. Otherwise a rule is placed in a Rule Block with one or more other rules. A procedure is an ordered set of rules; that is, the steps of a procedure contain sentences in the form of commands.
Example	Rule — The setting of the safety level must be adjusted • at least once an hour • whenever the scale has been changed.

Reference Collection

Theorem (or Generalization) Block

Introduction	Some maps deal with general statements, conceptions, inferences or principles. The Theorem (or Generalization) block is used to express such a statement.
Description	The Theorem (or Generalization) block gives a general statement that has been proved true or is conjectured to be true. When the statement provides an inference, conception or principle that gives general applicability to a particular concept, the term "Generalization" should be used. One or the other should be used to introduce a general statement, but never both.
Rules	• A Theorem (or Generalization) block is not used for a map introducing a new term. • A map may not have both a Theorem (Generalization) block and a Definition block. • If the theorem has a name, the block should be written as: Theorem name statement of theorem
Example One	The Theorem block for the Pythagorean theorem about right triangles would be written like this: Theorem — Pythagorean Theorem: The square of the length of the hypotenuse of a right triangle is equal to the sum of the squares of the lengths of the other two sides.
Example Two	The following is a generalization stating that independent events are not mutually exclusive events: Generalization — If any two events A and B with non-zero probabilities are independent, then they are not mutually exclusive; and if they are mutually exclusive then they are not independent.

Fact Block

Definition	Facts are sentences containing associations of such things as symbols, measurements, dates associated with events, experimental results, observations presented without supporting evidence. Fact Blocks contain statements of single facts or groupings of facts.
Example One	Columbus discovered America in 1492.
Example Two	The proper dosage for PhB is 2 grains.
Example Three	Tape speed: 1 7/8 to 120 inches per second.
Example Four	In the U.S. 67% of computers use some type of telecommunications equipment.
Rule	Put mnemonic devices (which are aids to remembering facts) in Fact Blocks (where needed). E.g., In 1492 Columbus sailed the ocean blue.

Parts Table

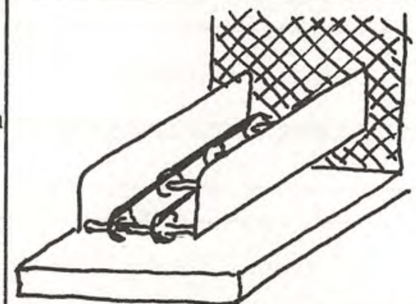
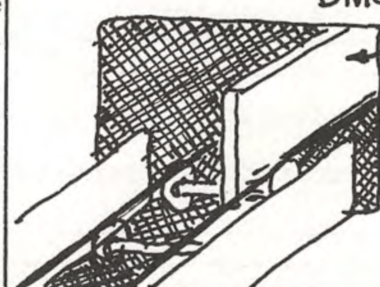
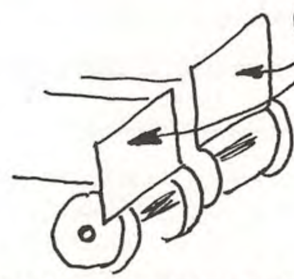
Introduction

Often it is necessary to describe parts of a structure. A parts table is used to describe or comment upon the parts.

Definition

A <u>parts table</u> is a table which contains the names of the parts of a structure, and optionally other information Blocks.

Example

Part	Location	Illustration	Purpose
Input Conveyor	At front of machine near bottom		Feed in units
Divider	Just inside front panel		Separate units into 2 lanes
Gates	Near center of machine		Hold units until wrapper is ready to receive them

Name of Map Block

Synonym: "Title Block"

Definition

The Name of Map Block tells the subject of the Information Map. It should be no more than one complete sentence and is usually a phrase or a word. Frequently, technical terms in subject matters are the names of Maps.

Rules

- The Name of Map Block is located at the top of the Map, and is displayed prominently, usually in capital letters or in larger bold face type.
- Every Map must have a Name Block.
- Every Name must be unique. (No two names of Maps should be alike.)
- The names should be informative and functional, not ambiguous or "cute".
- There are some special wordings for names of some maps:

Procedure Maps	always begin with "How to" or "Which" or a verb ending in "ing" (e.g. Operat<u>ing</u> a...)
Classification Maps	alwιys begin with "Types of" or "Kinds of"
Preview Maps	always use the words "Overview" or "Preview"
Review Maps	always use the words "Review of" or "Summary of"

These all help the reader identify what is coming up in the Map.

Comment

The Name of Map Block is obviously unlike other blocks in that it does not have a functional label and has a special place on the page. It is called a "block" arbitrarily--only to provide uniformity in definition.

Related Pages

preview maps, 106   review maps, 103

Introduction Block

Definition

The Introduction Block is an "advance organizer" for the information to be presented in the rest of the Map. It gets the reader ready for what he will be learning and contributes to the continuity of the Information Mapping materials, which otherwise contain little by way of transition.

Use

The Introduction Block is a multi-purpose block which can be used to do one or more of the following:

- provide transition from previous map
- supply some of the context for the concept to be defined next
- identify the significance of the idea that is about to be introduced
- discuss some memory aid or technique that may provide some support for retention of the learning
- raise a question or problem and state the solution generally or loosely
- present the reason or need for the concept in the subject matter
- give a "rough" definition of a concept that will be defined more formally in the Definition Block
- indicate the relationship of the new concept to prerequisite concepts
- startle or challenge the reader ("'Rubbish!' That is what many scientists say about. . .")
- raise the reader's interest by presenting quoted remarks
- present the history or background of a part of the subject

Example One

Here is an example from a popular psychology course:

> Among the most practical concepts of everyday psychology is the idea that about all of what you see--particularly in motivations of other people--is a projection.

Example Two

Here is an Introduction Block from a computer program:

> The Kludge Komputer Kompany has recently entered the telecommunications market with a new telecommunications interface called the MINIAUTODIGIMATIC-101.

Comment Block

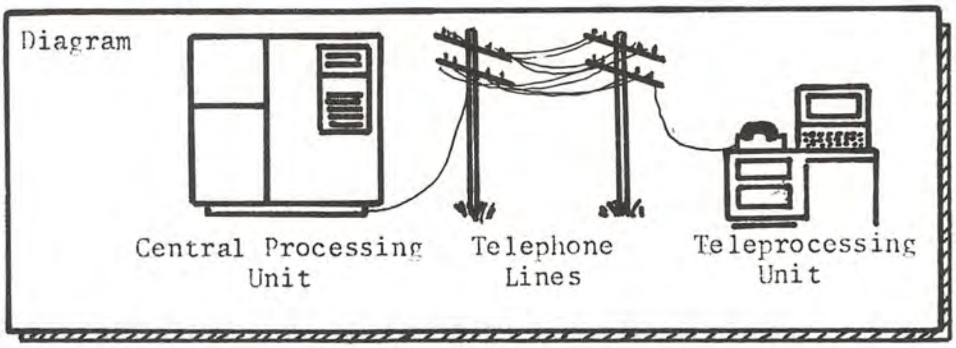
Introduction	An author may find in dealing with a concept that he wishes to add some remark or information that does not easily fall into one of the other Block categories.
Definition	A Comment Block is used to present any additional information that might be helpful but which cannot be sorted into any of the Information Block categories. Thus, a Comment Block may include: • miscellaneous information pertinent to the subject matter, such as "rules of thumb" • "left-over" clarifications and learning aids • interesting but tangential remarks • useful "hints" on problem-solving • common misunderstandings • memory aids • historical notes • suggestions for where to find additional information.
Rules	No information that can be sorted into one of the other categories should be included in the Comment Block. A Comment Block may be associated with any other Block or the whole Map.
Example	The following are the Definition Block and the associated Comment Block from a map on "Complement of a Set": **Definition** — The Complement of a Set contains all the members or elements that are not found in that set, but are found in the universal set. The complement is an operation defined on only one set. **Comment** — Note that when we talk about the complement of a set we must state explicitly the universal set.
Comment	Many beginning writers fall into the trap of overusing the Comment Block. Don't use it as a "cop out." Check to see if the information you are about to put into a Comment Block can better be put into another type of Block.

Synonym Block

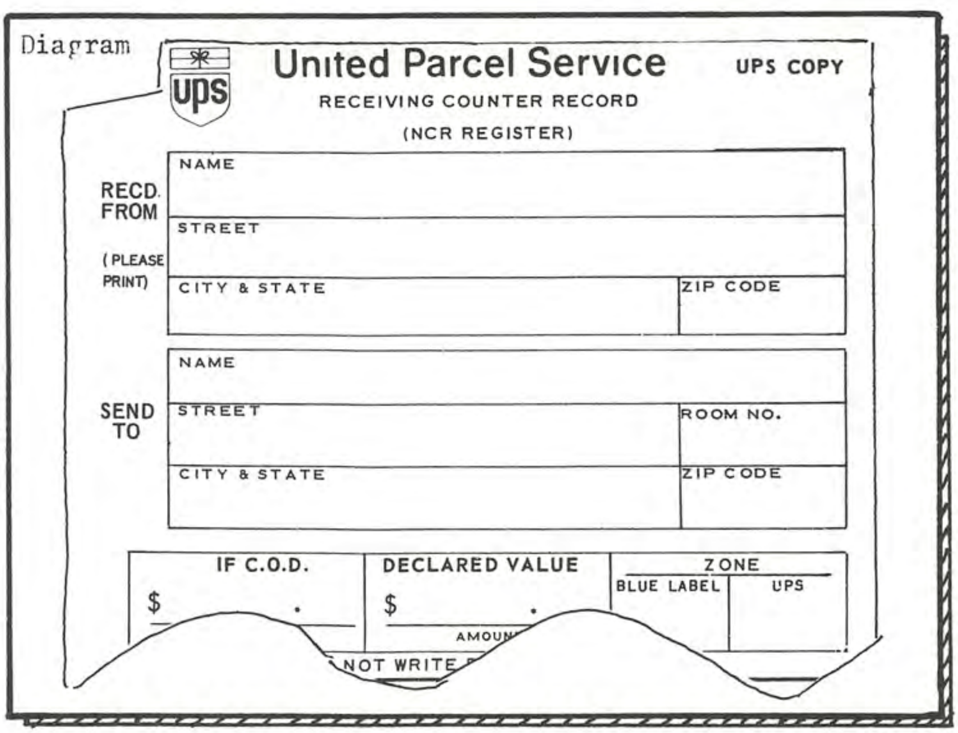
Introduction	Often, the word, phrase, or technical term under discussion has a synonym which is sometimes used.
Definition	The synonym block contains any alternate terms which are used to designate the concept under discussion.
Rules	All synonyms which are commonly used in the literature of the subject area should be included.
Example One	The following Name and Synonym Blocks are used in a chapter on graphic displays: TABLE — synonym: "matrix" or "array" FLOW CHART — synonym: "flow diagram" DECISION TABLE — synonym: "decision logic table"
Example Two	OUTPUT HOPPER — synonym: "poop shoot"
Use	The Synonym block is always associated with the Name block and is always at the top of the page in printed Maps.

Diagram Block

Introduction	Pictures often speed comprehension or recollection of a concept.
Definition	The <u>Diagram Block</u> contains some kind of visual representation of the concept being presented. They may include photographs, line drawings, etc.
Comment	Diagram Blocks may be used in various types of Maps and also may be an element (or part) of another type of Block.
Example One	In a course on telecommunications, the following Diagram Block was used:



Example Two	In a Map on a form for shipping, the following was used:



Analogy Block

Introduction	Sometimes an author may think of a relation or likeness between two things or of one thing to or with another that he thinks will provide a useful learning aid.
Definition	The Analogy block is used to present a statement of "likeness" of the concept at hand and some element from the reader's probable range of experience.
Use	The Analogy block is used as a vivid way of highlighting the concept under discussion. It should enlighten the understanding of the concept and help to fix it in memory.
Rules	• Avoid contrived analogies. The purpose of an analogy is to help the reader understand the concept, not to confuse him. • The Analogy block may contain more than one analogy. However, there is one Analogy block per map.
Example	The concept of "destructive read-in"of a computer system was illustrated with this more familiar parallel:

Analogy	Tape recorders also have the property of destructive read-in. If you put a tape, which already has music recorded on it, on a tape recorder and record something new on the tape, the original music is destroyed.

Use Block

Introduction	When learning about a new concept, people frequently ask: • What is this used for? • What's the purpose of this? • What is the function of this?
Definition	The Use Block provides statements about the function, purpose, value or use of the concept under discussion.
Example One	From a Map on "variables" in a computer program:

Use Variable names can be used to name:

- scalars
- vectors
- matrices

Example Two

Use The Miniautodigimatic-101 can be used in the fields of:

- data collection
- on line data acquisition
- off line data preparation, and
- as a dumb terminal, to do calculations or routine typing.

Example Three

Use Term insurance should be used to provide temporary coverage where the need is created by a special situation.

It is not suitable for permanent life protection.

Related Maps Block

Introduction

One of the characteristics of Information Mapped materials is that they provide aids for easy and quick reference to materials mentioned or built upon in a given map. One of these aids is the Related Maps block which serves as a local index to put you in touch with definitions or descriptions of concepts relevant to the topic of the current map.

Definition

The <u>Related Maps block</u> contains the names and numbers of all related and prerequisite maps.

Use

The purpose of this block is to provide the numbers of maps to the user for quick review or reference to material relevant to an understanding of the current map.

Rules

- A Related Maps block must be provided for <u>every</u> map that presents new information.
- There is only one Related Maps block per map.

Example One

The following is the Related Maps block from a map on union in the book on set theory:

Related Maps	sets,2 intersection, 21 union of three or more sets, 20	elements of a set, 3 forming unions from sets with different memberships, 19

Example Two

Related Maps	gate, 42 flippers, 31	input chain, 33

Notation Block

Introduction	When the concept under discussion requires specialized symbols or abbreviated expressions to express technical facts or quantities, then the Notation block must be included.
Definition	The Notation block of a map describes the symbols used to express technical facts or quantities associated with the concept under consideration. The Notation block usually includes these parts: • how to read the symbol out loud • what it means or stands for • other commonly used alternative symbols

Example One

Notation	The factorial for a number is written by placing an exclamation point (!) after the number. So, 8! is read "eight factorial" and means that you multiply 8 x 7 x 6 x 5 x 4 x 3 x 2 x 1. In formulas, you will find n!, which is read "n-factorial". You can also write algebraic expressions such as (n-r)! which is read "n minus r factorial" and means first subtract r from n and then do the factorial multiplication.

Example Two

Notation	The equal sign is used to indicate equal sets: $A = \{a,b\}$ $B = \{a,b\}$ $A = B$ and is read "Set A is equal to set B," or "Set A has the same members as set B." If R and S are not equal sets, we sometimes write $R \neq S$

Description Block

synonyms: How Does It Work? Block
How Does It Look? Block

Introduction	The term "description" is ambiguous and broad, yet very necessary, as there are many Blocks of information which may be labelled descriptions.
Definition	Description Blocks give descriptions of • physical things, or • physical processes.
Example One	Here is a Description Block of a physical thing:

Description	The programmed function keyboard is a part of the display unit. It contains 32 keys which are used to communicate with the computer. There is a thin plastic sheet which fits over the keyboard, called an overlay. Printed on it are descriptions of what each key does.

Example Two	Here is a Description Block of a physical process:

Description	Clouds are formed when warm, moist air (usually coming from the sea) meets a mass of cool, dry land air. The warm air rides up over the cool air. The rising air is cooled by the high altitudes to a temperature at which it cannot hold large amounts of water vapor. If the temperature gets cold enough, the water vapor condenses into visible droplets which we see as clouds.

Example Block

Introduction	Examples are crucial to any learning materials. Too frequently we find that something is defined and either no instances of it are given, or the number is insufficient to cover the range of the term being introduced. In Information Mapping we hope to minimize these problems by introducing a formalized set of rules to govern the writing and inclusion of examples.
Definition	An Example Block gives a single instance of the concept being presented.
Comment	Frequently Information Maps have associated with them Application Exercises or Feedback Questions which ask the learner about examples.
Rules *(Number of Examples)*	• Write enough examples (or feedback question which ask the learner about examples) to sample the entire range of variation covered by the definition and by the situations the learner is likely to encounter. • Every Map that introduces a technical terms, or that gives a generalization, property, relationship, or rule, must include at least one Example Block. • If a Map contains more than 5 or 6 examples, consider whether classifying examples into a table is appropriate.
(Content of Examples)	• Each Example Block must be self-contained and completely spelled out. • No new information may be introduced in an example. • Use as much visualization (illustrations, etc.) as possible. • Do not use trivial, overly complex, unfamiliar, or far-fetched examples.
(Order of Examples)	• Number the Example Blocks from easiest to hardest if possible.

Non-Example Block

Synonym: Counter Example

Introduction

If you are teaching a child what a dog is, you point to many examples of a dog and say "dog." Pretty soon the child, if he is old enough, begins to say "dog" when he sees a furry, moving thing. Often, the child will say "dog" when he sees a furry, moving *cat*. We tell him "No, that isn't a dog, that's a cat." *And* he begins to look for differences between cats and dogs before he uses the label again. A cat in this situation is an example of a "significant non-instance" of the concept "dog."

The child *doesn't* say "dog" when he sees a piano or a chair or a person. These, of course, *are* non-instances of the concept "dog," but they are not *significant*. That is, for *this* situation, they do not resemble a dog sufficiently to *lead* the child to label them "dog."

Definition

A *Non-Example Block* presents an example of something the reader already knows (or which he may encounter) that may be confused with the concept under discussion.

Use

A Non-Example Block is used to anticipate difficulty and to help obviate it. Its purpose is to sharpen a reader's discrimination of a concept.

Example One

In a Concept Map explaining the biological family "fish," the whale and dolphin should be pointed out as mammals, *not* fish. This distinction would be presented in a Non-Example Block.

Example Two

Non-Example	A teletype connected directly to the central processing unit is *not* regarded as telecommunications, but *rather* as a direct hook-up.

TASK 4. LIST THE JOB RESPONSIBILITIES, Continued

Example Two

Insurance Course

The underwriter is responsible for:

- selection, classification, and review of risks in accordance with the policies of the company
- authorization of endorsements using company guidelines
- writing letters to policy holder, lienholders, and others

etc.

Task 5. List the General Goals of the Materials

Description

At this point in the writing of assumptions you should list (in any order you wish) the general goals of the course. These should be stated in terms of what the learners will be able to do at the end of the course. You will have a variable number depending on the size of the course.

Example One

Binary Numbers Course

When the user has finished this course he should understand:

1. how number systems are constructed
2. why the Binary System is used in computers
3. why the octal system is used in computers
4. how to convert between different number systems
5. how to do simple arithmetic in various number systems, including the standard method and the complementary method
6. those concepts of data processing that relate to number systems, particularly the Binary and Octal Systems.

Comment

Later, you will be making very specific objectives for the course. The general goals will give you the course's broad boundaries.

Further Reading

Mager, Robert F., Goal Analysis, Belmont, Calif., Fearon, 1972.

Example Two

Service Engineers

The field service engineer should be able to:

1) explain how the machine and its subparts work

2) operate the machine

3) use the engineering documentation system

4) find and rectify any type of machine malfunctions

5) fill out report forms correctly

6) deal with "customers" effectively.

Task 6. Write Specific Behavioral Objectives

Introduction

Some people find it useful to have a statement of instructional outcomes in the form of objectives stated in terms of observable behavior. And many prefer to do this before specific test items are written. You can do that if you wish. You can also skip this step and be guided by the written exam, especially if it is complete.

Definition

" Behavior..............refers to any visible activity displayed by a learner (student).

Terminal behavior.....refers to the behavior you would like your learner to be able to demonstrate at the time your influence over him ends.

Criterion.............is a standard or test by which terminal behavior is evaluated" *(p. 2)

"An objective will communicate your intent to the degree you have described what the learner will be DOING when demonstrating his achievement and how you will know when he is doing it."*(p.53)

Procedure

"To describe terminal behavior (what the learner will be DOING):

- Identify and name the over-all behavior act.
- Define the important conditions under which the behavior is to occur (givens or restrictions, or both).
- Define the criterion of acceptable performance."*(p.53)

Comment

For persons who wish to learn in detail how to write behavioral objectives, we recommend:

Mager, R. F., Preparing Instructional Objectives, Fearon, Palo Alto, Calif. 1962.

Example One

Binary Numbers Course

Here are some behavioral objectives from a Binary Numbers course: (partial list)

1. Students will be able to tell the difference between positional and non-positional number systems.
2. Given an example, students will be able to explain the meaning of radix notation.
3. Given a number, students will be able to express it in the appropriate exponential notation.
4. Given 2 binary numbers, students will be able to
   - add them
   - subtract them
   - multiply them.

continued on next page

TASK 6. WRITE SPECIFIC BEHAVIORAL OBJECTIVES, continued

(Continued) Example One

5. Given a binary number, students will be able to
   - convert it to decimal
   - convert it to octal.

6. Given a decimal number, students will be able to
   - convert it to binary without the help of the Map
   - convert it to octal without the help of the Map.

7. Given an octal number, students will be able to convert it (without using any references) to
   - binary
   - decimal.

8. Given the base (radix) of a positional number system, students will be able to
   - list its numerals
   - make an addition table
   - make a multiplication table
   - convert its numerals to decimal
   - convert decimal numerals to it
   - subtract.

Comment

The purpose of writing specific behavioral objectives is to guide you in determining what evaluation events you need to develop to test whether or not students have met the objectives. For many of these evaluation events, you will be preparing test questions.

(Continued)
Example One

ANSWERS

1. A positional number system is one in which an ordered finite list of numerals is used and in which the position of the numeral from the point dividing the whole number from a fraction determines the value of the numeral. In a non-positional number system, a numeral always has the same value, regardless of position.

2. A. octal eight
   B. radix
   C. 8_{10}

3. A. $(3x10^4)+(5x10^3)+(8x10^2)+(9x10^1)+(2x10^0)+(3x10^{-1})+(4x10^{-2})+(5x10^{-3})+(6x10^{-4})+(9x10^{-5})$

   B. $(5x8^5)+(7x8^4)+(3x8^3)+(4x8^2)+(2x8^1)+(7x8^0)+(2x8^{-1})+(3x8^{-2})+(6x8^{-3})+(4x8^{-4})$

   C. $(1x2^3)+(1x2^2)+(0x2^1)+(1x2^0)+(1x2^{-1})+(1x2^{-2})+(1x2^{-3})+(0x2^{-4})+(1x2^{-5})$

4. A.
```
 1101
+ 011
10000 <---- Answer
```

   B.
```
 1101
- 101
USING ONES COMPLEMENT METHOD
 Complement of 0101 is 1010

 1101
+1010
10111
  + 1
 1000
```

   C.
```
    1101
   x 101
    1101
   0000
  1101
 1000001
```

Task 8. Write Reference Objectives for the Materials

Definition	Reference Objectives specify the performance of a given book in terms of looking up information initially or at a later date after initial learning. While there is no canonical form for writing Reference Objectives, some of the examples will be suggestive.
Examples	The book will be accessible for reference through standard detailed table of contents (in the form of a 3-level outline) and a keyword index. The organization of the book will be such that the final use of reference takes precedence in structuring the material over the initial learning use. The reference use is secondary, and material added to initial learning use for reference shall be included in short appendices at the end of chapters. These appendices will be printed in smaller type face than that of the initial learning material. The following topics will be included to aid reference users of the book but are not regarded as important for initial learners: (list would follow).

Example Two (continued)

LIST OF KNOWLEDGE TOPICS:

1. Risks
2. Endorsements
3. Policy

The list of knowledge topics obviously comes directly from the technical terms mentioned in the list of procedures. From your knowledge of the field you may very well be able to add other topics. In this example you may know that there are certain types of risks, each of which would "feel" like it would take a complete Map to describe. You may also know that there are 15 specific endorsements that the company puts on a specific type of policy. The names of each of these would be added to the list of knowledge topics.

Related Pages

objectives, 189
concept maps, 88
job procedures, 201
structure maps, 49
job responsibilities, 186
process maps, 77

Task 3. Determine Type of Map

Introduction

Provisionally, we will regard each of the topics which you identified in Tasks 1 and 2 of this chapter as the names of Maps.

The procedures will obviously become Procedure Maps.

For the others, you will have to identify the exact type of Map so that you can begin drafting the Map.

Description

Next to each topic on your list of knowledge topics, list the type of Map. You can use the table below as well as your general knowledge of Mapping to make this identification.

THESE "CLUES" SUGGEST...	...THIS TYPE OF MAP
physical objects office forms pieces of equipment "Can I draw a picture of it?" the words "parts of..."	Structure
words like • "kinds" • "types" • "is divided into" • "may be sorted into" • "is a sort of"	Classification
operations which have stages or phases operations you describe chronologically, cyclically transformations from one state to another descriptions of relationships like attraction, movement, action-consequences	Process
new terms that are not associated with the categories above important relationships between other concepts important rules, principles, or generalizations	Concept

Related Pages

structure maps, 48
classification maps, 58
process maps, 76
concept maps, 87

TASK 3. DETERMINE TYPE OF MAP, Continued

Example One	LIST OF KNOWLEDGE TOPICS	MAP TYPE
Binary Numbers Course	1. Positional number systems	Classification ("kinds of" is implied by the plural)
	2. Non-positional number systems	
	3. Radix	Concept
	4. Binary numbers etc.	Concept

Example Two	LIST OF KNOWLEDGE TOPICS	MAP TYPE
Insurance Course	1. Risks	Classification ("kinds of" is implied)
	2. Endorsements	Concept or Classification if all of the types are listed
	3. Extension of coverage endorsement etc.	Structure (usually it is composed of fixed words added to a policy)

Example Three	LIST OF KNOWLEDGE TOPICS	MAP TYPE
Keyboard Input Course	1. The Datamatic 4450 Input Terminal	Structure
	2. Keyboard	Structure
	3. Display Screen	Structure
	4. Input forms	Structure
	5. What the machine does when you make an input correction	Process
	6. What happens to data in the buffer memory on input etc.	Process

Application Exercise

DIRECTIONS: The following pages contain groups of unlabelled blocks. Cut them apart. Decide what blocks and maps they belong to, and tape them on blank sheets of paper. Label the blocks and give names to the maps.

Where there is time, indicate where and what types of Feedback Questions and Criterion Questions will be used.

If you think other information is needed (e.g. examples, transitions, introduction, etc.) feel free to add it.

Here is some general information about the course to which these blocks belong.

1. NAME OF YOUR PROJECT: The Physiology of Stress

2. Purpose and General Goals of Your Course: To enable user, a drug detailman or student, to understand the general physiology of the stress reaction and its relevance to everyday life.

3. Identify learner (user) population for the course: drug detailman, students in nursing and other paraprofessional schools in the medical sciences, students of psychology

4. Estimated size of course (pages,hours): 25 to 35 pages

5. Setting for the course (classrooms, carrells, at home, etc.): offices, classrooms, laboratories

6. Schedule and Deadlines for Course Development (and any other important developmental constraints): 2 months

7. List the specific job responsibilities of the person being trained, that are relevant to the course you are preparing (attach additional sheets if necessary):

   Drug detailmen, to explain to doctors the use of anti-stress drugs
   Others, to relate human behavior under stress to underlying physiology

8. List the Specific Behavioral Learning Objectives of the course.

   a. Able to indicate what happens when parasympathetic and sympathetic nervous systems are activated
   b. Able to describe how stress is related to the automomic nervous system

THE PHYSIOLOGY OF STRESS

The autonomic nervous system is concerned with maintaining the internal environment of the person.

The autonomic nervous system is a system of nerves and ganglia which activate the blood vessels, heart muscle, smooth muscles, viscera, and glands.

The autonomic nervous system is generally regarded as <u>not</u> under voluntary control, although recent research with biofeedback devices has shown that persons can obtain voluntary control over at least some autonomic functions.

The autonomic nervous system is composed of two sub-systems:

- the parasympathetic nervous system
- the sympathetic nervous system

The sympathetic nervous system, when stimulated, results in mobilization of resources to prepare the body to meet emergencies and situations where exertion is required.

During fear or rage, the sympathetic nervous system diverts bloodflow to skeletal muscles for running or fighting.

The general stimulation of the parasympathetic nervous system promotes vegetative functions of the body such as conserving and restoring energy, digestion, excretion, etc.

During digestion and rest, the parasympathetic system diverts blood flow to the stomach.

Most organs receive neural input from both the sympathetic and parasympathetic nervous systems. Thus their activity at any one time is a result of a balance of the two opposing influences of the two systems.

A stress situation is any situation in which a person feels threatened enough by his environment, real or imagined, to produce an alarm reaction.

When faced with real danger such as being attacked by a tiger in the jungle or almost hit by a car there is a real threat to the life of a person and an alarm reaction occurs.

Stress can result from a threatening memo, possible loss of a job, upset in family or personal life.

Obviously, different situations will be more or less threatening for different persons. Typically when you feel fear, anger, rage, jealousy, anxiety, you are in a stressful situation.

The body's reaction to threat is to get ready to fight or to run. This alarm reaction is controlled by the sympathetic nervous system.

Instantly, as threat is perceived or exertion needed, the autonomic nervous system makes the following changes in the body:

- the pupil of the eye opens wider (to better be able to see the danger)
- the heart rate increases (to pump more blood to the muscles)
- the blood vessels of the head, skeleton, and lungs dilate (i.e. relax and get larger) to pass more blood thru these areas and thus to pass oxygen to these organs
- the blood vessels of the abdomen contract so that little blood will be diverted to functions like digestion
- the sphincters (muscular gate-like structures) constrict in the rectum and around the bladder
- salivation decreases and sweating increases

And from the pituitary gland, hormones are secreted which immediately act on the adrenal glands releasing epinepherine (adrenalin) and nor-adrenalin (instantly energizing substances) which in turn stimulate the

- liver to release glycogen (stored sugar) into the blood stream for more ready energy
- the spleen releases more red cells to help circulatory system take in more oxygen and get rid of carbon dioxide

All of this happens no matter whether the perceived threat is being caught outdoors in a violent tornado or becoming furious at the boss for transferring your best assistant at a crucial time.

During activation of the parasympathetic nervous system, the following changes in the body occur:

- the coronary blood vessels constrict and the heart rate decreases (as the body prepares for relaxation

and inactivity)
- the bronchial muscles constrict permitting shallower breathing
- the gastric glands in the stomach begin secreting digestive juices
- the gall bladder, stomach, and walls of the small intestine and colon all begin peristaltic contraction (to move partially digested food and other material through)
- the sphincters of the stomach and small intestine, colon and urinary bladder relax (permitting flow of material through them)
- the pupil of the eye constricts and the tear glands secrete tears
- the salivary glands secrete saliva in the mouth
- the external genitalia have vasodilation in the blood vessels

It can be seen that the parasympathetic nervous system controls the relaxation of the body where routine, reconstructive functions can occur.

SAMPLE ANSWERS begin on page 225.

ANSWER

AUTONOMIC NERVOUS SYSTEM

Introduction	The autonomic nervous system is concerned with maintaining the internal environment of the person.
Definition	The autonomic nervous system is a system of nerves and ganglia which activate the blood vessels, heart muscle, smooth muscle, viscera, and glands.
Comment	The autonomic nervous system is generally regarded as <u>not</u> under voluntary control, although recent research with biofeedback devices has shown that persons can obtain voluntary control over at least some autonomic functions.
What are its major parts?	The autonomic nervous system is composed of two sub-systems: • the parasympathetic nervous system • the sympathetic nervous system.

ANSWER

SYMPATHETIC NERVOUS SYSTEM

Definition	The sympathetic nervous system, when stimulated, results in mobilization of resources to prepare the body to meet emergencies and situations where exertion is required.
Example	During fear or rage, the sympathetic nervous system diverts bloodflow to skeletal muscles for running or fighting.

PARASYMPATHETIC NERVOUS SYSTEM

Definition	The general stimulation of the parasympathetic nervous system promotes vegetative functions of the body, such as conserving and restoring energy, digestion, excretion, etc.
Example	During digestion and rest, the parasympathetic system diverts blood flow to the stomach.
Comment	Most organs receive neural input from both the sympathetic and parasympathetic nervous systems. Thus their activity at any one time is a result of a balance of the two opposing influences of the two systems.

ANSWER

STRESS SITUATION	
Definition	A stress situation is any situation in which a person feels threatened enough by his environment, real or imagined, to produce an alarm reaction.
Example One	When faced with real danger such as being attacked by a tiger in the jungle or almost hit by a car there is a real threat to the life of a person and an alarm reaction occurs.
Example Two	Stress can result from a threatening memo, possible loss of a job, upset in family or personal life.
Comment	Obviously, different situations will be more or less threatening for different persons. Typically when you feel fear, anger, rage, jealousy, anxiety, you are in a stressful situation.

ANSWER

ACTIVATION OF THE SYMPATHETIC NERVOUS SYSTEM Synonym: "Fight or Flight Reaction"
"Alarm Reaction"

Introduction

The body's reaction to threat is to get ready to fight or to run. This alarm reaction is controlled by the sympathetic nervous system.

Description

Instantly, as threat is perceived or exertion needed, the autonomic nervous system makes the following changes in the body:

- the pupil of the eye opens wider (to better be able to see the danger)
- the heart rate increases (to pump more blood to the muscles)
- the blood vessels of the head, skeleton, and lungs dilate (i.e. relax and get larger) to pass more blood through these areas and thus to pass oxygen to these organs
- the blood vessels of the abdomen contract so that little blood will be diverted to functions like digestion
- the sphincters (muscular gate-like structures) constrict in the rectum and around the bladder
- salivation decreases and sweating increases.

And from the pituitary gland, hormones are secreted which immediately act on the adrenal glands releasing epinepherine (adrenalin) and nor-adrenalin (instantly energizing substances) which in turn stimulate

- the liver to release glycogen (stored sugar) into the blood stream for more ready energy
- the spleen to release more red cells to help circulatory system take in more oxygen and get rid of carbon dioxide.

Comment

All of this happens no matter whether the perceived threat is being caught outdoors in a violent tornado or becoming furious at the boss for transferring your best assistant at a crucial time.

ACTIVATION OF THE PARASYMPATHETIC NERVOUS SYSTEM Synonym: "Relaxation Response"

Description

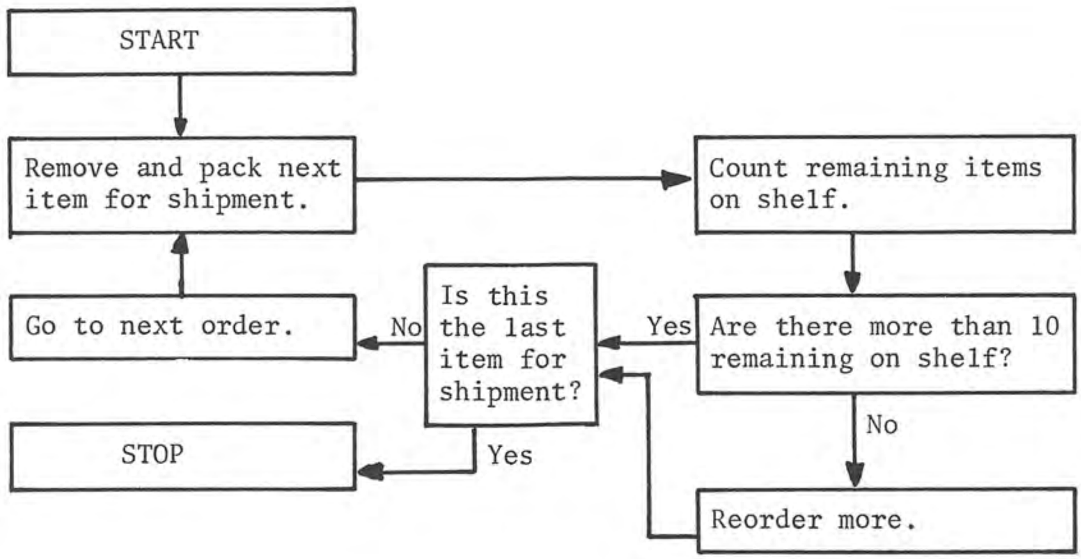
During activation of the parasympathetic nervous system, the following changes in the body occur:

- the coronary blood vessels constrict and the heart rate decreases (as the body prepares for relaxation and inactivity)
- the bronchial muscles constrict permitting shallower breathing
- the gastric glands in the stomach begin secreting digestive juices
- the gall bladder, stomach, and walls of the small intestine and colon all begin peristaltic contraction (to move partially digested food and other material through)
- the sphincters of the stomach and small intestine, colon and urinary bladder relax (permitting flow of material through them)
- the pupil of the eye constricts and the tear glands secrete tears
- the salivary glands secrete saliva in the mouth
- the external genitalia have vasodilation in the blood vessels.

Comment

It can be seen that the parasympathetic nervous system controls the relaxation of the body where routine, reconstructive functions can occur.

6.



7. A. Flow Chart
   B. Block Diagram
   C. Block Diagram

8. A. Start Box
   B. Action Box
   C. Connector
   D. Action Box
   E. Decision Box
   F. Stop Box

Chapter 14
Making Decision Tables

Overview

Introduction	A decision table can be used to present a procedure which contains many decisions, which has a "tabular" or symmetrical structure. In this chapter you will learn the skill of making decision tables.
Objectives	At the completion of this chapter, you will be able to: 1) identify the different parts of a decision table, given the chapter for reference 2) identify the different kinds of decision tables given the chapter for reference 3) make simple decision tables, given a paragraph or list containing pertinent information.

Related Pages procedure map, 36 parts of a decision table, 274 kinds of decision table, 284

Basic Structure of the Decision Table

Description

A decision table structures if-then relationships in tabular format. One part describes the circumstances (or conditions) that exist, and the other part describes the action the user must take for each set of circumstances.

Diagram

RULES	CONDITIONS "IF"	ACTION "THEN"
1		
2		
3		
4		
5		
6		

	RULES 1	2	3	4
CONDITIONS				
ACTIONS				

What Are the Basic Parts of a Decision Table?

PARTS OF THE DECISION TABLE	DESCRIPTION
Rules	A rule is given for each combination of conditions that apply in the decision situation
Conditions	All of the circumstances or situations or aspects which can determine whether or not an action takes place are put in the Conditions column.
Actions	All of the things that are to be done or identified are placed in this column.

INFORMATION MAP FEATURES FOR EASE OF REFERENCE, continued

(continued) List of Features	• Capsules provide "kernel" statements of key rules or concepts • Flow charts show graphically the sequences of events in a process • Indexes aid information retrieval.

Broad Design Principles

These principles lead to...	...these implications for the design of educational materials.
Chunks of information should be separate and modular for easy revision, updating. Scanning needs to be easy for the user. <u>Critique of present practice</u>. Paragraphs all look alike even though they contain different information. They are frequently unlabeled as to type.	Invent a new "chunk" of information. We called it the "Information Block." We determined that for explanatory writing there are 38 such block types (e.g. definition, example, description, comment, etc.). We defined a simple, but effective set of writing rules to go with them. We imposed the rule of functional label on each appearance in text of each type.
The reader needs to be able to find out where he is at and what the page and its parts are about quickly.	Label each map. No "cute" titles. Only informative ones. Standardize certain ones (e.g. all procedures start with "how to...") Locate labels in one place (top right or left). Standardize that for a book. Label each functional part as already mentioned.
Page design should be uniform for similar types and in so far as possible "tip off" the learner as to the kind of learning he can anticipate. Graphic designers have come up with some basic solutions to ways information shows what is happening.	Blocks are laid out on a page from top to bottom and have horizontal lines between them. Certain types of blocks and learning look different from each other. Routinize the use of standard graphic formats and synthesize these with the block concept.

BROAD DESIGN PRINCIPLES, continued

Keep the basic system simple so that a professional can learn the the rudiments in one day.	▷	Limit the initial area of concern to explanatory subject matter. Rule out areas such as role playing, case histories, simulation games, planning, etc. for now. Work on them later.
The same information can be displayed in different media.	▷	Separate the "rules" for organizing and categorizing the information from the rules for displaying it.
Learners take rules seriously, But characteristically also want to deviate from them.	▷	Formulate all rules in the system in for form of "hard" rules (i.e. couched in the form of "always", "must", etc.) Then indicate where some rules need "softening."
Much of writing is fuzzy and filled with transitions.	▷	Keep transitional and introductory material in a single place. Put all of the "meat" in specific places.

How People Should Behave toward Large Bodies of Complex Information

The assertions below about the way people should behave toward large bodies of complex information lead to...	...these implications for the design of instructional and reference materials.
We should not suggest, or insist that people remember great amounts of the detail in a subject matter, if they can look it up. People are forgetting organisms.	What people "look up" and "learn on the spot" should be made maximally clear and easy to learn from. It should also be easy to find. Indexes and tables of contents, as well as subheadings should be maximally complete and clear.
On first going through some new subject matter, people should be able to go as fast as possible, omitting detail as they choose. The overall structure of the subject matter should be clear to them. People are good scanners of information. People are good at seeing patterns.	Design materials for skimming and scanning, i.e. many subheads, as regular as possible. Map the important structures in subject matter graphically.
Because people like to use what they have learned from for reference...	...the same material used for first learning should also be used for reference where this is possible.

Analysis of Difficulties Encountered by Learners

These analyses of difficulties encountered by learners lead to...	...these implications for the design of instructional materials.
Learners will stop and flounder around if they find they don't understand something. • This may be due to not having learned a particular pre-requisite. • This may be due to having forgotten a particular pre-requisite.	Local indexes on each page should give the learner immediate access to previous pages in the book (or to other interconnected books) which he can use to look up pre-requisites.
Prose looks the same page after page. You can't tell by glancing at a page, what kind of learning it will demand.	Different kinds of things (e.g. procedures, cycles, concepts, etc.) should look different on the page. Hence, Information Map formats for different kinds of things. Routinely use these formats.

Analysis of What "Good" Learners or Referencers Do

These observed behaviors of learners lead to...	... these implications for the design of instructional materials.
Many learners skim a whole chapter or a whole book "to see what's there" (i.e. to get an "overview") before reading the whole text.	Design the typography of formats such that headings can be skimmed easily. Put a name at the top of every page. Table of Contents should list the name of every page.

History of Information Mapping

1963-1990

Information Mapping, Inc.
Archives Department

The History of Information Mapping -- The Official Story

Newsletters from an Autobiography

By Robert E. Horn
Chairman
Information Mapping, Inc.

Information Mapping, Inc.
300 Third Avenue
Waltham, MA 02154
(617)890-7003

Two Papers Are Precursors of Information Mapping Research

Learner-Controlled Instruction Experiments Influence Design of Method

New York, N.Y., 1963-64. Robert E. Horn conducted several experiments in learner controlled instruction which seem to have influenced his later development of Information Mapping's method. In these experiments, various kinds of instructional materials were developed that provided students an opportunity to control their own goals and sequences through the subject matter.

In one experiment, students wrote questions on pieces of paper and handed them to the experimenter over a partition between their two desks. The experimenter then searched a file of pre-prepared answers and gave the most appropriate one back to the student. Horn noted that this endeavor focused his attention of what constituted a good answer to a student question. And it also focused his attention on the kinds of questions students asked. He felt that this was fundamental in shaping his interest in coming up with a fundamental taxonomy which later became known as "information blocks." (Editor's Note: Two of these research reports were published as Horn, R.E. "Learner-Controlled Use of Information Retrieval Systems," *Programmed Instruction*. Vol. IV, No. 2, November, 1964 and Horn, R. E., Experiment in Programmed Learning, in Runkel, P. , Harrison, R., and Runkel, M (eds.) The *Changing College Classroom*, San Francisco, Jossey-Bass, 1969)

Horn Completes Multi-Media System on Developmental Testing

New York, N.Y., 1963. What are the best ways to get feedback from students and revise instructional materials? This is the subject of a book (accompanied by an audio tape) by Robert E. Horn, who is Director of Training and Consulting Services at CPI, a New York non-profit R & D organization, devoted to developing better instructional materials.

Why this subject? It is one of the most crucial topics in instructional design, according to Horn. Also, because it involves the training of people in interpersonal skills, i.e. of listening to students talk about what difficulties they had with learning from the new self-instructional material, it is one of the hardest challenges he could think of in developing training material.

The course material will be tested in CPI's courses, which are given by Horn and at the University of Michigan School of Business, where Horn teaches once a month.

(Editor's Note: This multimedia course was subsequently published as *Developmental Testing* by the University of Michigan and was in print for many years.)

Task Analysis Survey and Taxonomy Branching Techniques Published

New York, N.Y., 1963. Two early papers of R. E. Horn published this year were precursors the invention of Information Mapping's method. Horn's earliest paper in the field of education was called "A Taxonomy of Branching Techniques," which collected and analyzed the different types of branching that a learner could encounter in the newly invented programmed instruction and computer based instruction fields. The paper was published by CPI in New York City where Horn was employed as Director of Training and Consulting Services. The paper showed how important it is to have a complete classification of the types of basic units in an instructional system.

The second paper was called "Systematic Task Analysis" and was also published by CPI. It collected together all of the major task analysis methods available to educational and training analysts working on making the development of instructional materials more systematic.

Exam Question System Incorporating Six Basic Information Types Developed by Horn

Approach Outlines How Authors Can Analyze the Types of Behavior Called for in Final Exams

Learner-Controlled Sequencing Designed Unique Graduate Course at Columbia

New York, N.Y., 1964. Students in an graduate course at Teachers College will use a series of learning stations arranged like sit-down museum exhibits to study in a demonstration of learning controlled sequencing. The experiment has been devised by the instructor in the course, Robert E. Horn, a research associate at Columbia University.

Basic to the plan is the idea that student should be as self-directed as possible and that careful design of educational environments can make this learning effort much more profitable.

This is not merely a change in room arrangement. It is also a change in teacher role. The teacher acts as more of a coach and less as an information transmitter in this learning environment. The information is in the learning stations, which contain instructions, books, audiovisual material, and data.

(Editor's Note: The research report on this experimental course appears as Horn, R. E., Experiment in Programmed Learning, in Runkel, P. , Harrison, R., and Runkel, M (eds.) The *Changing College Classroom*, San Francisco, Jossey-Bass, 1969)

Horn Finishes Book on General Semantics and History of English

New York, N.Y., 1964. *Language Communication and Change* is the name of a new book just completed by Robert E. Horn, a research associate at Columbia University's Institute for Educational Technology.

The book is a supplementary text for High School English classes. It is divided into two parts. The first part covers the history of the English language and topics in word origin and how language changes.

The second half of the book focuses on general semantics and covers topics such as how symbols give meaning, the process of abstraction, and how to improve communication using the tools of general semantics.

(Editor's Note: The book was published in 1967 by Science Research Associates (SRA) a subsidiary (at that time) of IBM.

Horn Participates in First Public Demo of CBI Authoring System

New York, N.Y., 1964. IBM and Columbia University's Institute of Educational Technology showed the first "authoring system" for a computer-based training system, developed by Ralph Grubb of IBM. He was assisted in the presentation by R. E. Horn of the Institute.

New York, N.Y., 1963-64. A system that enables training writers to analyze the types of behavior to be called for in final examination questions has been developed by Columbia University researcher, Robert E. Horn. It establishes six basic types of information: concepts, procedures, operations (now called processes), structures, classification, and paired associates (now called facts).

For each of these types of information, certain specific subtypes of information have been defined that can be asked about. For example, in asking about concepts, one can ask about the name of the concept, its definition, and about instances or non-instances (now called examples or non-examples) of the concept. Moreover, these can be asked about in two distinct situations: recall and recognition. The important departure used in this approach is that the typology is based "upon the form of the questions rather than upon their content," according to a forthcoming article by Mr. Horn.

(*Editor's Note:* The article referred to is "A Terminal Behavior Locator System," which appeared in the British journal *Programmed Learning*, February 1966 This journal is now known as *Educational Technology International*)

Horn Develops Basic Information Mapping Concepts While Conducting Research at Columbia Univ.

Method Defines Blocks and Maps as Alternative Way to Analyze, Organize, Sequence and Display Information

Initial Development Focuses on Faster and Easier Learning and on Efficient and Effective Retrieval

New York, N.Y., Winter 1964-65. A new method of writing training materials has been developed over the past few months by Robert E. Horn, a Research Associate at the Institute of Educational Technology, Columbia University. The method is aimed at making initial learning faster and easier and at the same time enabling rapid, effective retrieval of information that has been forgotten.

Information Blocks

The method has some unusual aspects in that Horn declares that the paragraph is obsolete for the training materials and documentation written with the method. These are replaced by a new unit of information called the "information block" which is far more carefully defined. Horn has discovered that approximately 80 percent of the information in the average textbook of any subject matter can be sorted into approximately 40 such blocks. Another property of the information block is that they all have a label which declares the type of information they contain.

"The function of labeling every information block is to enable readers to scan quickly to find what they want in retrieval," Horn explained.

The blocks are also written so that only one "kind" of information is contained in them, that indicated by the label. "The idea, " Horn explained, " is to keep out extraneous information so that when people decide to read a block, after reading the label, they will get exactly what the label promises."

Information Maps

Another new unit of organization has also been advanced as part of that theory. Called informally the Information Map, this unit organizes two to nine information blocks linked to a specific subject matter together under a descriptive map title. "We are currently experimenting with keeping all of one map on a single page with the map title at the top of the page," Horn declared. "This also will help readers to scan quickly in a book to see what they want to read." The combination of the blocks and maps gives a very strong structured "feel" to the reading and writing. The labels often carry the transitions and the blocks often have the feeling of being self-contained.

Horn has also combined the discovery of this analytic method with an earlier set of patterns which reached publication this year in a British journal. The theory asserts that a subset of the forty blocks of information can be regarded as "key" and can be divided into six types of information: concepts, structures, procedures, processes, classifications and facts. This permits a rigorous analysis of the subject matter and a way of providing a completeness analysis, since you can see what blocks should be a part of a topic (since you know its information type) and thus can literally see if it is there or not.

Technology of Writing

Horn believes that the taxonomies of information blocks will enable us to have a theory of instructional materials. Such a theory will enable practitioners to discuss with great accuracy what they are working on and thus provide the foundations for a true technology of information transfer. You have to have the right units for writing just as biologists have to have a taxonomy of cells and cell types before the field can advance. These new information blocks provide the definition and taxonomy for such a science and technology to proceed, Horn believes.

All Federal Education, Training, and Research Programs to be Subject of Retrieval Service

Appleton-Century-Crofts Supports Early Application Research on Method as Part of Development of Federal Information System on The Great Society

Washington, D. C. early 1966. The publisher Appleton Century Crofts engaged Robert E. Horn to design and develop a new information retrieval system that will keep grantsmen informed of the availability of Federal funding in the new Great Society programs. In the past few years, the Federal government has begun to provide a large variety of new programs for schools, colleges and universities, and nonprofit organizations. The number of these programs has grown to over 400. There is no one place where information about these programs can be found.

The aim of the new information system will be to provide this information in easily scannable, accurate, and up-to-date form. The new product called The Guide to Federal Assistance for Education, Research and Training is intended to become the grantsman's Bible. (Editor's Note: The system achieved that reputation as all major universities, colleges, schools and nonprofits became customers. The product was sold for $325 per year which included 12 monthly updates.

Horn's role was to design and develop the product, hire and train the management and staff in Washington, D. C. that would collect, process, and distribute the information. The product launch was set for a year and a half after the start date. The product served as a flagship for The New Century Division.

Unusual Design of Guide

The Guide to Federal Assistance had a number of quite original design features incorporated into it. It was the first major product to begin to incorporate some of the features of the Information Mapping method. The information was divided into small labeled chunks, called Information Blocks.

A careful organization of the blocks and a systematic approach to the labeling enabled users to scan and find the information quickly.

In addition all the information was printed on file folders and came in a 2 foot long, colorful, metal file box . This enabled the users to put their own notes about the program in the folders and take the folders with them to meetings.

Name Invented for the Method During Project at New Century

V.P. Charles Walther Credited with Acting as Stimulus for Change

New York City. Summer 1966. The New Century Division of Appleton Century Crofts provided a small contract to further the research on the Information Mapping Method. During this project, the name "Information Mapping" was conceived.

Charles Walther, Vice President of Appleton Century Crofts and Director of the New Century Division, was the first "believer" in the new method. He is also credited with telling Horn that the original name Horn gave to the method was not good enough. What was the original name? Information Structure Designs. Walther said bluntly, "Go back and think of a different name."

Information Resources, Inc., Formed; Begins Work on $78K Air Force Research Contract to Evaluate Information Mapping

Team Forms to Write Experimental Instructional Materials Using the Method and Test Them in Educational Settings

Lexington Massachusetts, May, 1967. The recently invented Information Mapping methodology will be thoroughly evaluated in a project supported by the United States Air Force Systems Command. A new company, Information Resources, Inc., has been formed as the organizational entity to manage the project.

The $78,000 project will be managed by the new company's president, Robert E. Horn. The company's first headquarters was rented at 96 Mt. Auburn St. a block from Harvard Square over the famous liquor store at that location known to all Harvard students.

Dr. Betty Nichols was hired as the first employee of the company. She is a veteran researcher in psychology and education. She and Mr. Horn had worked together on a project at the Children's Museum of Boston to incorporate evaluation, feedback and revision cycles in museum exhibits.

First Major Writing Projects Puts Information Mapping to Work on Computer User Manual

Software Will Serve Drug Researchers at Industrial Research Lab

Lexington Massachusetts, Spring, 1967. The second contract awarded the young company implementing the Information Mapping methodology calls for the development of a computer language manual, called CANARD (and subsequently called CONVRS) The company hired its first subcontractor to handle the writing of the project.

(Editor's note: The project was canceled after approximately half the manual was written as the software company that had contracted for the manual went into bankruptcy. Information Resources, Inc. lost $10,000 on the project.)

First Course Ever on Information Mapping Taught at Harvard

Information Mapping Introduced to Research Community as Horn Teaches Course at Graduate School of Education

Cambridge, Massachusetts, Summer, 1967. The newly invented Information Mapping method was taught at Harvard University this summer by its originator, Robert E. Horn.

The course, Research in Instruction, usually taught by Dr. Douglas Porter, was devoted entirely to experimental applications and evaluations of the method. Fifteen graduate students from as many different disciplines, used the principles and guidelines of the method to develop course materials for educational projects from grade school through graduate school levels.

The purpose of the course from the perspective of the developer was two fold: (1) to understand the problems in teaching the method and (2) to begin to see how widely the method might be applied in different subject matters.

From both standpoints the course was a success. The students found the method very useful in the development of curriculum material. For example, the projects varied from elementary science and mathematics, art theory, to graduate dentistry.

The method appears to be teachable, at least on the graduate level. There were some initial problems with the understanding that information blocks were quite different from paragraphs. It took quite a bit of the summer to understand fully the implications of the structured approach to writing that is the main feature of the methodology. The course materials used at Harvard are expected to be very valuable in bringing new staff at Information Resources up to speed on the method as they join the evaluation project in the fall.

I.R.I Team Develops First Textbook Using Information Mapping

Group Writes Introduction to Probability for Experimental use in Graduate Level Statistics Course

Researchers at I.R.I Test Instructional Materials at Harvard's Graduate School of Education and at Tufts Univ.

Results Show Information Mapping is Effective in Teaching Difficult Topics in Probability. Method is Preferred by Students Over Traditional Text

Cambridge, Massachusetts, 1968. In the first major evaluation of the new method of Information Mapping, researchers from Information Resources, Inc. conducted experiments at Harvard University and Tufts University. The tests were designed to demonstrate the effectiveness of the new method. Control groups received the same materials without the careful labeling of the information blocks and the titles of the maps, according to Elizabeth Nicol who designed the experiments. The results of the experiments showed that students learned from the new materials. In a second part of the experiment, students were invited to come over a pick up free materials from the offices of I.R.I. When they arrived, they were given a choice of the experimental materials labeled according to Information Mapping guidelines or the control group materials (unlabeled). The students overwhelmingly picked the Information Mapping materials.

Simulation Game Presented at State Univ. of N.Y.

Washington D. C., Summer 1968. Information Resources, Inc. conducted its first simulation game for the Federal Liaison Officers of the 40 campuses of the State University of New York this summer. The aim was to teach sales management skills and the basics of grantsmanship so that there would be an expert on the Federal programs on each campus. The simulation called "The Federal Marketplace" was closely tied to Appleton-Century-Crofts new information system, "The Guide to Federal Assistance to Education and Training." The simulation game was written by Robert E. Horn, President of Information Resources.

Cambridge, Massachusetts, 1968. The research team evaluating the new Information Mapping approach to developing training and educational materials has completed its first book. It is an introduction to graduate level study in probability theory. The group also developed several chapters on various topics of mathematics necessary for introductory statistics.

The book is approximately 150 pages long and includes practice exercises for all of the concepts and procedures introduced. It will take a student approximately 10 hours to study. The authors of the material were Robert E. Horn, the project director, Elizabeth Nicol, the project research psychologist, Michael Grace and Joel Kleinman, graduate students at the Harvard University Statistics Department.

"We used the book to thrash out the guidelines I had been working on for a couple of years," Horn said. "It is one thing to suggest a taxonomy that is supposed to work for any subject matter, and quite another to see if it can work with four authors on one subject matter."

Air Force Sponsors Second Major Research Project on Information Mapping

$95K Contract Will Evaluate Usefulness of New Method for Computer-Based Instruction Software

Cambridge Massachusetts, 1969. After presenting a research report that described the successful experiments at Harvard and Tufts Universities last year, the researchers at Information Resources, Inc. received a follow-on grant to investigate combining the new Information Mapping method with computer based instruction.

A major aim of the project will be to determine whether it is possible to produce highly individualized instructional sequences. This is like producing a different book for each learner. The project will examine the possibilities of presenting instructional sequences that resemble the traditional programmed instruction that has been implemented as computer-based instruction. These sequences are determined by the computer system, thus, they involve the system gathering a great deal of information about the learner as the interaction progresses.

At the other end of the spectrum, the system to be designed in this project will enable learners to control the sequence of the learning by making choices based on various access aids. Thus learners will be able to skip around learning only what they feel they need at the moment.

Both of these kinds of sequences and all of the possible combinations in between will be run off the same database of information, that is, a collection of information blocks about the subject matter.

Research on The Guide to Simulations/Games for Education and Training Begun

Team Begins Gathering Data to Produce a Consumer's Report for New Field of Educational Simulations.

Cambridge Massachusetts, 1969. Information Resources, Inc. began a major new research project aimed at producing a consumer's report for the newly invented field of educational simulation games. These simulations provide situations for students to play the roles and make the decisions as if they were people actually involved in the system being simulated. Thus, for example, in business simulations learners play business executives who have to make financial, marketing, operating and sales management decisions.

The consumer's report will be called *The Guide to Simulations/Games for Education and Training,* and will be jointly edited by David Zuckerman and Robert E. Horn. Simulation gaming is one of the fastest growing and most important educational fields, yet there is a dearth of information about what is commercially available and how good it is. Simulation gaming is an important complementary technology to Information Mapping in that it emphasizes learning through interaction with the subject matter and with other students.

Second Major Instructional Simulation Game Designed and Delivered at SUNY

"Supplemental Funding" Teaches Grantsmanship to School District Federal Liaison Personnel

Cambridge Massachusetts, 1969. Information Resources, Inc. has adapted its Federal Marketplace simulation to address the needs of the School District level Federal liaison officers. The simulation was played for the first time at the State University of New York at Genesco. Coauthors of the simulation were J. A. Sarthory and D. E. Wade of SUNY Genesco and Robert E. Horn of I.R.I.

First Edition of The Guide to Simulations/ Games for Education and Training Published by I.R.I.

Consumer's Report on Instructional Material is Hailed as The Standard Reference Work in Field

Cambridge, Massachusetts, 1970. Information Resources, Inc. published a new book which is rapidly becoming the standard reference book in the emerging field of simulation gaming. The compendium lists detailed information on 404 simulations and games available to be used for education and training. In addition, the book lists 450 more simulations and games that are in development or about which the editors had insufficient information to compile complete entries.

The book covers all of the subject matters of a modern school system or university and indicates that the methodology of simulation is being widely experimented with.

Audiovisual Instruction magazine called *The Guide* "...a most comprehensive directory to this rapidly changing field." and in *Scientific American* Martin Gardner called it a "...valuable reference...". And a reviewer in *Simulation/Gaming News* said that the book has "...an obvious edge in the amount of information given concerning a particular game."

Instructional Simulation on Program Planning and Budgeting (PPBS) Developed and Presented

Course Gives Needed Skills to School System Personnel

Cambridge, Massachusetts, 1970. Information Resources, Inc. has developed a new training course entitled Program Planning and Budgeting. The course consists of a series of simulation exercises that are to familiarize school system administrators with new management and financial methods that have recently been employed in the Federal government.

Staff members from Information Resources, Inc. have played the series with groups of school administrators in Massachusetts this year to test out the effectiveness of this form of training for this type of curriculum and for this audience.

Simulation on Decision Making Developed for National School Boards Association Annual Conference

San Francisco, CA. 1970. Robert E. Horn developed and presented a new simulation whose subject is cutting the budget of school systems. The goal of developing the simulation is to have an exercise that fit into approx. 50 minutes of instruction from instructions to debriefing. This is a long-felt need in the field of simulation which requires real participation to understand it, according to Horn. The simulation was something of a shock to school board members. They expected Horn to talk about simulation rather to participate in one.

But they got into the swing quite quickly and two board members playing parents in the simulation angrily held a protest with placards denouncing the school board for cutting important programs out of the budget.

(*Editor's Note:* Because of its ability to create instant involvement and to be played in one class period, *Participative Decision Making* became probably the most widely played simulation in the decade of the 70's)

Second Major Research Report on Information Mapping Shows Method Helpful for Individualized Instruction & Reference

Report to Air Force Shows Innovative Design for Computer Based Instruction System Aiding Instruction and Information Retrieval

Cambridge, Massachusetts, 1971. The research team evaluating the new Information Mapping method has produced its second major book-length report. This report focuses on how a computer based instruction system might be designed that would provide individualized sequences for different kinds of learners.

The report said, "An important difference between this system and others lies in the variations in degrees of control that this system can exercise over the sequencing of information.

"In the majority of CAI systems, the path of the learner is almost totally determined by the computer program. In a few other systems, the so-called 'ad lib.' systems, it is the user who determines what information is called up from the database.

"Our Learning-Reference System is designed to operate not only under either one of these extremes of total user control or total system control, but also at any one of numerous points in between. In other words, the learner can take charge of all sequencing decisions, he can share some with the system, or he can be totally dependent on the system for information selection and display.

"This range of possible controls adds another set of dimensions for individualizing instruction, but most importantly at this imperfect stage of our knowledge, it allows experimental control of variations in learning conditions so that research may refine the prescriptions that link personal data, information sequences, and learning results."

Results of Information Mapping Research Presented at International Educational Conference in Brazil

Benefits of Method Explained to Educational Technologists in Rio

Rio de Janeiro Brazil, 1971. The first report on the results of the research phase of the new Information Mapping method was presented at the First International Conference on Educational Technology in Rio de Janeiro in June by Robert E. Horn, who has led the research team evaluating the method.

Article Appears in Japanese Educational Technology Journal

Tokyo, Japan, 1971. Horn's Brazil speech was published in the *Japanese Journal of Educational Technology.*

British Industrial Trainers and Academic Researchers Taught Information Mapping at Psychology Department at Sheffield University's Training Center

Sheffield, England, 1972. The second time Information Mapping has been taught was at the Department of Psychology of the University of Sheffield. The Department had a training center for industry which sponsored two courses taught by Robert E. Horn, the originator of the method.

A group of educational innovators attended the course and began immediately to experiment with the new method in both academic and industrial settings.

Information Mapping Taught to Graduate Students at American University's School for Continuing Studies

Washington, D. C., 1972. Robert E. Horn gave a graduate course in Information Mapping at the School of Continuing Education sponsored by the Center for Educational Technology this Spring.

Two Articles on Information Mapping Appear in Professional Journals in U.S. and U.K.

Cambridge, Massachusetts, 1972. The research journal published by the National Society for Performance and Instruction, *Improving Human Performance* published an article describing the theory that comprehends the new Information Mapping method, this year. The article describes the innovations of information blocks and maps and identifies the types of maps and blocks that the method uses.

A second major article also appeared in a journal published in England this year. This article was an interview conducted by Quinton Whitlock with Robert E. Horn. It was published in *Industrial Training International* Magazine,

During the course of the interview, Whitlock observed, "The thing that impressed me, and I think a number of other students, not only in the one day but on the four day course, was this kind of double edged power of the information block -- that it not only replaces or substitutes for...a paragraph in narrative terms as a means of presenting information in a more logical and orderly way, but it has this other format function....in the sense that the physical shape, dimension of the block and its design and relationship to other blocks reveals the structure of the information presented. In other words the presentation and the look of the thing, aids learning as much as the content. "

First On-Site Overseas Seminar on Information Mapping Taught to Rank-Xerox in England

Trainers of People Who Service Photocopy Machines World-wide Taught to Write Instructional Materials Using the New Method.

Outside London, England 1973. Information Resources, Inc. gave its first on-site seminar on the new Information Mapping method to trainers at Rank-Xerox corporation in England this summer. The trainers will use the method to help develop self-instructional and reference materials for people who repair photocopy machines.

Second Edition of the Guide to Simulations / Games Published

Cambridge, Massachusetts, 1973. The third edition of the constantly growing *Guide to Simulations/Games for Educaton and Training* was published this year. It was edited by Robert E. Horn.

Major Information Mapping Consulting Project Begun with Harvard School of Public Health.

Cambridge, Massachusetts, 1973. A major consulting project was begun this spring with the School of Public Health at Harvard University. Robert E. Horn has contracted with a team that is producing a new set of course materials on educational planning and instructional materials development for persons in the allied health professions. The textbook will be used in a four hour course at Harvard. The project is sponsored by U. S. Agency for International Development.

(Editor's Note: This project resulted in the publication of *Systematic Course Design for the Health Fields* by Segall, A, Vanderschmidt, L., Burglass, R, and Frostman, T. 1975, John Wiley & Sons Publisher. *Systematic Course Design* shows the strong influence of the method on every page. Ruanne Burglass, who actually drafted most of the book, was one of the earliest and best writers to use the method. She helped teach one of the eary seminars the following year.)

First On-Site and Multi-Client Information Mapping Seminars Presented in U.S.A.

First Version of Developing Procedures, Policies, and Documentation Developed

Lexington, Massachusetts, 1974 Information Resources, Inc. rolled out its new seminar for the first time this year in the United States. After successful presentation of the course in England the last two years at Sheffield University and at Rank Xerox, the seminars were judged ready for the training profession in the United States.

It is expected that the seminar will be given every other month in different locations around the country. First locations are Boston, New York, Washington, D. C. and Los Angeles.

On-site seminars will also be offered to clients.

Educational Technology Magazine Features New Tool to Overcome the Paper Mountain

Lexington, Massachusetts, 1974. *Educational Technology* magazine featured an article by Robert E. Horn in its May 1974 issue. It focused on stories of initial applications of the method in a variety of situations: sales training at Allstate Insurance, management training at Cranfield University in England.

It also described the initial applications as Nissan Motor Corporation which is using the method to retrain its 3,000 technicians who repair Datsun automobiles. Further applications described were on task analysis, matrix algebra for business, and a teachers manual for volunteer counselors.

Article on Information Mapping Appears in Training Magazine

Lexington, Massachusetts, 1974 *Training Magazine*, published a seminal article by Robert E. Horn on the Information Mapping method, which the magazine described as "writing without paragraphs. Instead there's a set format to guide the writer and reader along the easiest pathway to communication."

The article surveyed the basic approach of the method and described how maps and blocks fit together to lead to a major revolution in writing.

(Editor's Note: In a subsequent issue, *Training Magazine* said: "Few articles have stimulated as much reader mail and telephone calls as Information Mapping by Robert E. Horn.")

First Adaptation of Information Mapping Seminar Developed for Insurance Services Organization

Custom Design of Key Series of I.S.O. Newsletters Taught in Beginning and Advanced Workshops

New York, New York, 1975. The Insurance Services Organization, a company owned jointly by all of the major insurance companies in the country contracted with Information Resources, Inc. for help in redesigning ISO's newsletter series. The twelve newsletters are issued as often as every day to insurance companies to help them keep up with fast breaking news about the insurance business in all of the 50 states.

Information Mapping was selected after a preliminary evaluation by I.S.O. personnel. It was selected because it provided a structured way to approach the problems being faced by the newsletter editors and their many subject matter experts on the staff of I.S.O. Information Mapping also was flexible enough to be modified to suit the needs of these newsletters.

A series of two beginning and two advanced seminars were given by Robert Horn at I.S.O. headquarters in New York City. I.R.I. also provided follow up editorial assistance as each of the redesigned newsletters published their first few issues.

Two Magazines Feature Information Mapping

Datamation and Training Magazines Feature New Method for Training and Documentation

Lexington, Massachusetts, 1975 Two important magazines published articles on Information Mapping this year. *Training Magazine,* published a follow up article to the one published last year after answering extensive questions from readers in the July 1974 issue.

The article covered further explanations of the method and provides a chart to help trainers determine when they should use Information Mapping in the preparation of training materials. Horn pointed out the important distinction that "Information Mapping should not be used to try to persuade someone to do something. It is designed only to provide people with the capacity to act...(not)the willingness to act," an assertion he has since retracted.

The second article appeared in *Datamation,* the premier data processing and computer magazine. This article was particularly focused on using the method for documentation and on the experience of the research group in keeping a large document up to date continuously as it changed day by day. The editors of *Datamation* noted in introducing the method that it "can relieve excessive pains of documentation."

Public Seminars Now Held Monthly

Lexington, Massachusetts, 1975 The boost given the method by national attention by important magazines has heightened interest in the method and has enabled Information Resources, Inc. to begin to offer their 5-day public seminar on a monthly basis.

It is offered at various sites both on the West Coast and East Coast.

Research Begins for 3d Edition of Simulation Guide

Lexington, Massachusetts, 1975. The Guide to Simulations/Games sold over 7,000 copies in its second edition . A third edition is under way.

Horn Receives Outstanding Research Award for Information Mapping from National Society

N.S.P.I. Gives Coveted Annual Award for Outstanding Research for New Method of Developing Training

Lexington Massachusetts, 1976 The National Society for Performance and Instruction gave Robert E. Horn, president of Information Resources, Inc. its Outstanding Research Award this year for his work on the Information Mapping method.

The citation read "In recognition of significant research contributions leading to applications in the field of performance and instructional technology."

The N.S.P.I. award is particularly coveted by researchers because of the elaborate set of criteria and tough evaluation standards set by the organization in giving its awards.

First U.S. Government Info-Map Seminar Given to U.S. Coast Guard Academy

Oklahoma City, Oklahoma, 1976. Information Resources, Inc. gave its first seminar to the federal government this year as the Coast Guard Academy hired the company to teach its 5-day course to instructional designers, writers, and trainers at its Oklahoma City, Oklahoma installation.

Developing Procedures, Policies and Documentation Course Published

5-Day Course Becomes Foundation for New Marketing Strategy of Company

Lexington Massachusetts, 1976. Information Resources, Inc. began selling copies of *How to Write Information Mapping* this year. These are the course materials for the training courses that have been given at universities, government agencies and businesses over the past few years. These course materials represent a basic introduction to the method.

(Editor's Note: Later this year the course materials were taken off the market and not sold except as part of the company's seminars. The primary reason for this was one of quality assurance. By actually doing the exercises in the courses the learners acquired skills that many did not achieve by simply reading the book.)

First Edition of *Writing Management Reports* Course Material Published

Two Day Course Teaches Information Mapping's Method to Mangers and Executives

Lexington, Massachusetts, 1977. Information Resources released its second major course in two years as it began giving public and on-site seminars in how to use the method for writing reports, memos, and proposals. Robert E. Horn wrote the course materials. He also taught the first several courses to regular clients of the company.

British Researcher Writes First Ph. D. Thesis on Information Mapping

Loughborough University, England, 1977. Alexander Romiszowski became the first person to write a doctoral level dissertation on the Information Mapping method. He was awarded the doctoral degree for *A Study of Individualized Systems for Mathematics Instruction at the Post Secondary Levels.* Most of the research was done with subjects in Brazil.

Horn Receives 1977 Champion Industrial Trainer Award from Training Magazine

Lexington, Massachusetts, 1977. Training Magazine's chief columnist Dugan Laird presented his annual MITCH award to Robert E. Horn this year for his work in Information Mapping. MITCH stands for My Industrial Training CHampion.

In giving the award, Laird said, "Bob Horn's book is well done. It covers an important skill by presenting theory lucidly...with lots of application and feedback opportunity."

Horn gives Keynote Speech at the North American Simulation and Gaming Assn.

Research Triangle, North Carolina, 1977. Robert E. Horn presented an invited keynote address to the North American Simulation and Gaming Association this summer. The speech was unusual in that Horn presented it as the instructions for playing the Convention Game at the convention.

Seminar Group Formed -- First Contract Instructor and Telephone Sales Person Hired

Lexington, Massachusetts, 1977. Information Resources, Inc. took a big step this year in hiring its first full time sales person. It also hired a part time contract instructor, Mr. John Cooper, who had previously taken the 5 day course while working for Equifax an Atlanta client of I.R.I.

Third Edition of The Guide To Simulations/Games Published by New Publisher, Didactic Systems

Lexington, Massachusetts, 1977. Continuing its strong presence in the simulation gaming industry Information Resources Inc. has finished the third edition of its popular standard reference book in the field.

The Guide doubled in size from its second edition describing over 1200 simulations and games in this edition. It will appear in 2 volumes, one devoted to academic simulations and games and one devoted to business simulations.

First Licensed Instructor Trained at Lincoln National Insurance Company

Will Teach Seminars at Nation's 12th Largest Insurer

Lexington, Massachusetts, 1978. Ms. Sara Bixler became the first instructor to teach Information Mapping courses inside her own company under a license agreement between Information Resources, Inc. and Lincoln National Insurance Company.

Ms. Sara Bixler went through a cycle of taking the 5-day course, co-teaching it with an I.R.I instructor and then solo teaching it under the certification of Robert E. Horn. She also produced a major document for her company using the method to demonstrate her proficiency in using the method.

First Bell System 5-Day Seminar Presented to Pacific Telephone

San Francisco, California, 1978. Robert E. Horn presented the first 5-day seminar to a Pacific Telephone group this year. It was the first seminar given to any of the Bell system companies.

By the end of the year the company had ordered several more seminars and was actively evaluating the course for possible licensing of an instructor from Pacific's staff to teach it internally.

Two Part-Time Instructors Join I.R.I to Teach Seminars to Growing Client List

Lexington, Massachusetts, 1978. Information Resources, Inc. added two more part-time contract instructors to teach its seminars to clients all over the country. The total number of I.R.I instructors is now three.

Graduate Seminar at Columbia University Features Information Mapping

New York, New York 1978. Bob Horn returned to Columbia University to teach a 5 day graduate class in Information Mapping this year in between semesters.

Top Training U.S. Army Training Command Experts at 4-Day Briefing

Fort Belvoir, Virginia, 1978. Top training experts from all of the U. S. Army's training posts gathered to take a 4 day seminar and briefing on the Information Mapping method from Robert E. Horn this summer.

Simulation Guide Supported by Exxon Foundation Grant and Will Be Published by Sage Associates

Key Decision Made to Concentrate I.R.I on Information Mapping Work

Lexington, Massachusetts, 1978. The Exxon Education Foundation awarded Robert E. Horn a grant for $99,000 to produce the fourth edition of *The Guide to Simulations/Games* for Education and Training. With this funding, it was decided to take Information Resources, Inc. out of the business of researching and producing The Guide. Sage Publications of Beverly Hills California will publish the book when the research is completed for the fourth edition.

(Editor's Note: The 4th Edition was published in 1980 by Sage, thus ending a 12 year project that significantly improved the way simulations were evaluated and gave a direct boost to the entire field.)

The Seven Major Principles That Govern Thinking About Structured Writing Developed as a Teaching Device

Lexington, Massachusetts, 1978. Robert E. Horn has developed sever major principles that help learners grasp what the method is all about. The are: 1. The chunking principle, 2. the relevance principle, 3. the labeling principle, 4. the consistency principle, 5. the integrated graphics principle, 6. the accessible detail principle, and 7. the hierarchy of chunking and labeling principle. We have been governed by these principles in the past but we have not actually stated them succinctly.

AT&T Challenges Company to Write Manual for Competitive Evaluation

Information Mapping Entry Wins Challenge with 50% Fewer Errors as AT&T Long Lines Division Chooses Information Mapping to be Company-Wide Documentation Standard

Lexington, Massachusetts, 1979. AT&T Long Lines Division established a team to evaluate its internal documentation. The team heard about Information Mapping's method through the grapevine from Pacific Telephone. The team approached I.R.I with a challenge. We will give you a copy of our best AT&T manual. We will also give you a contract to see if you can produce a manual that is better than ours. We will choose an evaluator and he will run tests to see if yours is actually better. Will you accept the challenge? I.R.I was happy to accept the challenge and a new team that had been in training was assigned to do the work.

Among the team members was Nancy Fohl, who had just joined the company as a contract writer.

The work was completed on schedule and the evaluation was conducted by AT&T evaluator Eric Shaffer. The Information Mapping version came through with flying colors. Learners who used it had 50% fewer errors than those who used the AT&T Manual. (Editor's Note: Eric Shaffer later reported on his evaluation in Shaffer, E. M. (1982) "The Potential Benefits of the Information Mapping Technique" *N.S.P.I. Journal.* February 1982, p. 34 - 38.)

The Shaffer report concluded, "Although the current version (of the AT&T manual) is generally considered to be in 'good shape' the IM version was significantly superior."

"During a series of simulated time reporting tasks subjects committed 54% fewer errors when the IM version was used, " Shaffer reported.

On the subjective side of the evaluation, Shaffer reported that learners said the following about the I.R.I.-written materials: "After the tasks, the subjects reported that the IM version 'Rambles' less, is more logically organized and seemed more "Trustworthy' and 'Friendly,' 'Confident,' and 'In Control' when using the IM version...Generally, the IM version was felt to be more 'Easy to Use.'"

"Although the scope of the study is limited, the importance of writing quality is clearly demonstrated. Revision of instructions by properly trained individuals, would seem to offer substantial payoffs in terms of efficiency, document acceptance, and the psychological state of the user," Shaffer concluded.

I.R.I Forms Consulting Division Which Will Write Documentation

Repeated Requests from Clients Prompt Decision

Lexington, Massachusetts, 1979 Based on the success of the AT&T Long Lines Challenge Project, I.R.I. launched a sales and marketing effort that would take it into the consulting business in a significant way. A division has been formed to sell and write training materials and documentation for major American companies.

First Licensed Instructor for Bell System Company Trained at Pacific Telephone to Teach Information Mapping 5-Day Course

San Francisco, California 1979. Pacific Telephone Company became the second company to license the Information Mapping method. Instructors will be taught to teach the method internally within Pac Bell. The method was adopted after an extensive internal evaluation, and after four on-site seminars had been taught to members of the training division.

DuPont Selects Information Mapping for $210K Documentation Project

I.R.I.'s Documentation Division Grows to 8 Writers

Lexington Massachusetts, 1980 The DuPont Company choose the new I.R.I. Documentation Division to develop the documentation for the largest computer system ever put in by the nation's eighth largest company. I.R.I. won in competitive bidding with companies several orders of magnitude larger. The DuPont managers were particularly impressed by the quality of I.R.I.'s people and with the method which they investigated very carefully before making the choice of vendors.

The project is estimated at $210,000. The software system is described as an order entry system which will serve two of DuPont's divisions. (Ed. Note: A DuPont division is as large as a Fortune 500 company.) The software will also serve many functions beyond order entry, including accounting, warehousing, shipping, and marketing.

The I.R.I. team will work closely with the DuPont software team to interview subject matter specialists and then write what is estimated to be over 2,000 pages of documentation.

Seminar Division Hires First Full-Time Instructor and Two Full-Time Telephone Sales People

Lexington Massachusetts, 1980 I.R.I. took a big step this year and hired its first full time instructor and expanded its staff of telephone sales people to two.

John Kelly, an instructor at a local college, was hired to go on the road for I.R.I. teaching the 5-day and 2-day courses.

AT&T Becomes Licensee of Information Mapping Seminars

First Long Lines Instructor Trained by I.R.I.

Basking Ridge, N.J., 1980 AT&T joined Pacific Bell as the second Bell company to have an instructor licensed by Information Resources to teach the Information Mapping method.

Fiscal Year '80 Gross Doubles

Sales Top $205,000 for First Time

Lexington Massachusetts, 1980 Information Resources, Inc.'s gross revenues doubled in the fiscal year 1980.

Combined sales of the Seminar and Documentation Divisions topped $205,000.

Sales top a Half Million Dollars as Company Again Doubles Size in One Year

Lexington Massachusetts, 1981 Information Resources, Inc. again doubled its sales in fiscal year 1981. The company is definitely on a growth curve as sales in both the Documentation Division and Seminar Division grew rapidly, according to Donald Kendall, Vice President for Operations.

Two Federal Agencies Pick Information Mapping as Method to Use in New Manuals

Housing and Urban Development and Health and Human Services Have Payroll Manuals That I.R.I will Analyze, Design, Write, and Evaluate

Washington, D. C. 1981 Information Resources, Inc. was picked in competitive bidding to develop payroll manuals for two major Federal agencies. The company will develop manuals for the U.S. Department of Housing and Urban Development and for the U.S. Department of Health and Human Services.

Pepsico Chooses Information Mapping for Its Corporate Personnel Manual

I.R.I Selected to Produce Document That Will be Used by Staff in Corporate Offices

Lexington Massachusetts, 1981 The Documentation Division of Information Resources, Inc. received an important boost this year as it was picked to write Pepsico's new Corporate Personnel Manual.

This would represent the first time that a personnel manual would be written by the Documentation Division. The I.R.I. team will work closely with the Human Resources team at Pepsico Headquarters.

New England Telephone Company Becomes Licensee of Method

Company Will Have Instructor Taught by I.R.I Seminar Division and Certified to Teach NET Employees

Boston Massachusetts, 1981 The third Bell company in three years has become a licensee of to teach the method internally. New England Telephone Company followed Pacific Telephone and AT&T into the fold this year.

This represents a strong showing in the Bell companies and also demonstrates the strength of I.R.I.'s concept of licensing instructors within other companies.

Information Mapping, Inc. Formed as Trademark Application Approved

Name Change and Trademark Will Strengthen Product Identification in New Marketing Initiatives

Lexington Massachusetts, 1982 A new company named Information Mapping, Inc. was formed this year to take advantage of the registered trademark obtained from the U. S. Office of Patents and Trademarks.

The company retired the old name, Information Resources, Inc. and used the name that had been used for the method as the name of the company. It was felt that limited marketing resources should go into only promoting a single name.

Seminar Division Offers 27 Multi-Client Public and On-Site Seminars During Year

Growth Continues as Information Mapping Used Widely

Lexington Massachusetts, 1982 The Seminar Division set a new record for itself by holding a total of 27 Public and On-Site Seminars during the fiscal year.

Scott Paper Hires IMI to Develop $480K Documentation and Training System Project

Lexington Massachusetts, 1982. Based on the successful work done for the DuPont company last year, the Scott Paper company hired the I.M.I.'s Documentation Division to prepare both the documentation and the training for a new order entry system that is being developed.

Sales Up 20% During '82 Recession

Company FY '82 Gross Tops $635,000

Lexington Massachusetts, 1982. While growth slowed, I.M.I. nevertheless got through the recession of the last year with a 20 % growth.

First Application of Information Mapping's Method for On-Line Documentation Completed

I.R.I Produces Training for Users of New American Medical Association Data Bases Offered on GTE's MINET System

Lexington Massachusetts, 1982. GTE and the American Medical Association have picked Information Mapping's method to develop a major online information system. The system will provide doctors around the country with information and evaluation of drugs. The information will be written by doctors and pharmacologists on the staff of AMA. GTE will develop the software.

I.M.I. will provide training for the AMA writers. A special course was developed by Bob Horn and Barbara Ross. It was delivered to the AMA in Chicago. In addition I.M.I. will help design the screens and has another contract to write all of the error messages for the new system.

Sales Top 1 Million Dollars as Gross Increases 77%

Seminar Division Offers 41 Seminars to Clients During Year. Documentation Division Completes 21 Projects

Waltham Massachusetts, 1983. Sales of Information Mapping, Inc. topped one million dollars this year as the company grew at at rate of 77% over the previous year.

Both the Seminar Division and the Consulting Division grew rapidly. The Documentation Division completed 21 consulting projects during the year and the total number of seminars offered was 41.

Federal Reserve System Data Processing Department Selects Information Mapping as Standard for User Documentation

12 Member Banks Will All Use Same Method in Documents They Develop for System Wide Use

Waltham Massachusetts, 1983. An important break through for the Documentation Division was accomplished this year as the twelve member banks of the Federal Reserve System settled upon the method as their standard.

This announcement followed several projects done by the Documentation Division and by extensive training of personnel of several of the Federal Reserve Banks around the country.

Three Major Presentations Made at National Conferences of Trainers by I.M.I. Staff

IBM Guide, American Society for Technical Communication and GTE National Training Conference Hear Talks

Waltham Massachusetts, 1983. Important presentations were made by I.M.I. staffers this year in an effort to improve visibility of the company on the national scene. John Kelly and Bob Horn made a presentation to the IBM users conference (GUIDE)

Other presentations were made at the American Society for Technical Communication and the GTE National Training Conference.

First Book of Philosophical Essays Using the Method Published

Lexington Massachusetts, 1983. Robert E. Horn has edited a group of papers presented at the first two Lexington Institute Conferences into a book. These papers were "retrofitted" with many aspects of structured writing. They don't fulfill all of the standard guidelines, because the literary form is that of an essay or philosophical paper.

The primary aspects of structured writing used in this approach were heavy use of chunking and labeling. As much consistency of labeling was applied as was possible considering that the papers were written by five different people in five different styles. However, the exercise shows that even limited use of major guidelines in the method improves scanning and understanding.

(Editor's Note: The book is called *Trialectics: Toward A Practical Logic of Unity* and is distributed by the Lexington Institute, 80 Marrett Road, Lexington, MA, 02173)

Sales up 67% as Gross tops $1.8 Million

Waltham Massachusetts, 1983. Sales of Information Mapping, Inc. topped $1.8 million dollars this fiscal year as the company grew at at rate of 67% over the previous year.

This rate of growth has put Information Mapping, Inc. into the ranks as one of the important companies in the training and documentation business.

It appears that the company is consolidating its position as the preeminent company in what some have called the "complexity niche."

This is the niche where complex, novel systems, technologies, and ideas have to be spread rapidly throughout a client company.

The advent of the personal computer has certainly aided the company's growth. I.M.I. company executives estimate that up to 40 percent of the Documentation Division's work is computer related. And the rapid growth of the seminar division is also spurred by the widespread use of the computer. There are many more people from MIS departments in our courses these days.

Documentation Division Completes 27 Projects, Delivering Over 9,000 Pages

Repeat Clients Lead the Way with 7 Projects with AT&T, 4 with the Federal Reserve, 3 with Datapoint and 3 with GTE

Waltham Massachusetts, 1983. The Documentation Division of Information Mapping completed another successful year with seven repeat clients, including 7 with AT&T.

The Division wrote over 9,000 pages of documentation and training materials in 27 projects. The Federal Reserve System continued to be a major repeat client with four projects.

Seminar Division Sells 67 Seminars as Sales and Training Staff Grows to Eight

Waltham Massachusetts, 1983. The Seminar Division of Information Mapping, Inc. delivered 67 seminars this year up from 41 the previous year.

The total staff continued to grow and now totals eight full time members. The clients of the Division continue to be major Fortune 500 companies, with high technology companies beginning to show up as regular customers. These high tech companies have realized that good documentation helps sell software and equipment and have turned to Information Mapping as a solution to that problem.

The Mapping Times 1986

Horn Names Gorman Chief Operating Officer

Waltham, MA. 1986. Following the resignation of Don Kendall, Doug Gorman became the Chief Operating Officer of Information Mapping. Gorman will be responsible for the sales, marketing and operating aspects of IMI. In a prepared statement, Horn said that Gorman had initiated a new management order within IMI and had been asked to assume formal responsibility for IMI's continued growth.

Horn and Gorman set targets of 20% growth for the company in each of the next three years.

IMI Develops Strategic Plan

Waltham, MA. 1986. IMI implemented a new strategic plan to drive the company's vision and operations into the 90's. The Company's fundamental goals were to grow revenues, to grow profits and to provide a productive and rewarding work environment. IMI employees will be involved in the operational planning process for their areas and will commit to achieving mutually agreed-upon goals.

COO Don Kendall Leaves IMI

Waltham, MA. 1986. Don Kendall announced his resignation from IMI to pursue opportunities at Saddlebrook Corporation. In wishing Kendall the best, Horn stated that Don had been respsponsible for IMI's growth and infrastructure development at a crucial point in IMI's history.

Kendall joined the company in 1979 and helped lead it though an stage of rapid growth.

User Documentation Seminar Launched

Waltham, MA. 1986. IMI released its first version of a seminar titled" Developing End User documentation, (DEUD) Based on the highly acclaimed Information Mapping Method developed by Robert E. Horn.

The seminar includes techniques and exercises designed to help technical writers develop documentation that will improve the performance of users of technology rich products.

First Instructor's Conference Held

Waltham, MA. 1986. The first annual IMI Instructor's Conference was held in IMI's conference room at 275 Wyman street. It was attended by 8 IMI and customer instructors from around the country.

IMI Achieves Record Sales and Earnings

Corporate Re-structuring Plan Announced

Horn Promoted to Chairman, Gorman to President

In a move that was expected by the investment community, IMI was re-structured to Insure IMI's continued growth. Horn announced that he would advance to Chairman of the Board and would pursue other interests beyond IMI.

The Company entered into a long term plan to re-purchase shares from Horn. Gorman made a significant investment in IMI stock.

Waltham, MA. 1987. For its fiscal year ended June 30, 1992, IMI achieved record earnings on sales of $2.8 million. This 40% growth rate was achieve through a return to fundamental values, expanded marketing and focused business operations.

Ross and Cluggish to Lead Seminar Division

IMI's President, Doug Gorman, announced that IMI's seminar division would be re-structured with Barbara Ross leading development and delivery and Cluggish leading sales and marketing.

Partnership Principles Proposed

In an address to the Corporation, Doug Gorman announced the adoption of a set of partnership principles to guide IMI's relationship with customers, employees and shareholders. "IMI is really a series of partnerships where each party has important responsibilities", said Gorman. " As IMI grows the partnership principles will become internalized by all of our constituencies to foster the kind of positive culture that we need to meet our goals."

The principles include the reciprocal responsibilities IMI and its customers, employees, stockholders, and suppliers have toward each other.

For example, responsibilities that IMI assumes to each of its customers include:

- Commitment to the customer
- Results that we commit to
- Focus on what we do well
- Quality service at a fair price
- Good communication

In turn, IMI expects its customer's to undertake a set of corresponding responsibilities in their part of the relationship, including:

- Well-defined requirements
- Fair compensation for results
- Good communication

The partnership principles included similar draft definitions for other relationships.

1985

Cluggish Hired to Re-vamp Seminar Sales -- Mary Anne Cluggish was hired to develop a strong professional sales force for IMI's seminar division. Mary Anne brings to her position, experience in sales and marketing at the executive level. In this position, she will develop the required collateral and marketing support tools to foster IMI's growth.

Horn Hires Gorman -- After meeting at a networking session of the 128 Venture Group, Horn hired Gorman to drive IMI's marketing efforts. In his capacity as a consultant, Gorman will develop a strategic plan for IMI, develop a sales thrust for senior executives and launch IMI's new seminar titled "Developing End User Documentation."

1986

IMI Develops Strategic Plan -- IMI implemented a new strategic plan to drive the company's vision and operations into the 90's. The Company's fundamental goals were to grow revenues, to grow profits and to provide a productive and rewarding work environment. IMI employees will be involved in the operational planning process for their areas and will commit to achieving mutually agreed-upon goals.

Documentation Seminar Launched -- IMI released its first version of a seminar titled" Developing End User documentation, (DEUD) Based on the highly acclaimed Information Mapping Method developed by Bob Horn, the seminar includes techniques and exercises designed to help technical writers develop documentation that will improve the performance of users of technology rich products.

COO Don Kendall Leaves IMI -- Don Kendall announced his resignation from IMI to pursue opportunities at Saddlebrook Corporation. In wishing Kendall the best, Horn stated that Don had been respsponsible for IMI's growth and infrastructure development at a crucial point in IMI's history.

Gorman Becomes COO -- Following the resignation of Don Kendall, Doug Gorman became the Chief Operating Officer of Information Mapping. Gorman will be responsible for the sales, marketing and operating aspects of IMI. In a prepared statement, Horn said that Gorman had initiated a new management order within IMI and had been asked to assume formal responsibility for IMI's continued growth.

Instructor's Conference Held -- The first annual IMI Instructor's Conference was held in IMI's conference room at 275 Wyman street. It was attended by 8 IMI and customer instructors from around the country.

1987

IMI Achieves Record Sales and Earnings -- For its fiscal year ended June 30, 1992, IMI achieved record earnings on sales of $2.8 million. This 40% growth rate was achieve through a return to fundamental values, expanded marketing and focused business operations.

Partnership Principles Proposed -- In an address to the Corporation, Doug Gorman announced the adoption of a set of partnership principles to guide IMI's relationship with customers, employees and shareholders. "IMI is really a series of partnerships where each party has important responsibilities", said Gorman. " As IMI grows the partnership principles will become internalized by all of our constituencies to foster the kind of positive culture that we need to meet our goals."

Corporate Re-structuring Plan Announced, Horn Promoted to Chairman, Gorman to President-- In a move that was expected by the investment community, IMI was re-structured to Insure IMI's continued growth. Horn announced that he would advance to Chairman of the Board and would pursue other interests beyond IMI. The Company entered into a long term plan to re-purchase shares from Horn. Gorman made a significant investment in IMI stock.

Ross and Cluggish to Lead Seminar Division -- IMI's President announced that IMI's seminar division would be re-structured with Barbara Ross leading development and delivery and Cluggish leading sales and marketing.

1988

Vallone Joins IMI to Head Consulting Business -- Carol Vallone joined IMI to direct IMI's consulting division. Gorman and Vallone sought an employment partnership based on their previous experience working together at Carleton Corporation. In announcing the new hire Gorman speculated that Vallone's drive and energy would set a new standard for IMI's consulting efforts.

IMI Establishes Distribution Agreement for Canada -- IMI announced that InfoPro, a subsidiary of Bell Canada had been appointed as IMI's exclusive agent for Canada. InfoPro markets Bell's expertise to industry and government. Bill Draper of Bell said that the distribution agreement was a logical extension of our in-house contract. Marketing efforts will be driven from the success that Bell has achieved internally with IMI's method. Bell intends to develop a French version of IMI's seminars.

Corporate Brochure Released -- IMI released its first Corporate Brochure. The brochure is designed to enhance IMI's visibility in the rapidly expanding corporate market. The brochure presents a consistent high level message that promotes IMI's ability to help organizations improve the effectiveness of their written information.

Gumby Award Established -- IMI established the Gumby Award to recognize the outstanding contribution of employees of IMI. IMI's management team of Gorman, Vallone and Ross stated that the Gumby award would be given for whatever reason they decided at intermittent intervals, but always for performance above and beyond the normal. The first recipient of the Gumby award was ______________.

1989

Vallone Promoted to Vice President - Takes Ownership Position in IMI -- Based on record sales and earnings in the Consulting Division and her contribution to IMI as a whole, Carol Vallone was promoted to Vice President. Simultaneously, Vallone purchased a significant number of IMI shares, saying that the investment presented an opportunity for her to achieve financial security while creating the kind of company where people at all levels could thrive.

Sales top $4 million with Record Profits -- IMI announced record sales and earnings for the most recently completed fiscal year. Growth was strong across divisions and product lines within the company.

IMI Moves Headquarters -- Information Mapping announced that it would move its headquarters to 303 Wyman Street. This move will increase its useable space by more than 50%. Staff size

Instructors Top 25 -- IMI announced that its instructors topped 25 including IMI and client instructors. Jerry Paradis, Director made the announcement at IMI's third annual instructor's conference held at the Eagle Mountain House in Jackson, NH.

Horn Publishes "Mapping Hypertext" -- The Lexington Institute became the publisher of "Mapping Hypertext" a new book by Robert Horn. The book promises to revolutionize the creation of hypertext documents by suggesting a conceptual approach to make such documents perform better. The book has received accolades from industry press and prominent management specialists like Richard Saul Wurman and Ken Blanchard.

IMI Announces Scandinavian Distributor -- IMI appointed KUF., a Danish Corporation with headquarters in Skanderborg, Denmark as its exclusive marketing agent for Denmark, Norway, Sweeden and Finland.

Goal Systems to Offer Information Mapping Seminars and Consulting Services with Preference -- Goal Systems and Information Mapping announced a marketing agreement to couple IMI's proprietary method of document development with Goal's Preference product. Dave Wetmore, President of Goal stated that the agreement resulted from the obvious synergy between the respective products of the two companies.

Ross Becomes Vice President -- Barbara Ross became an officer of IMI. Barbara has been responsible for the 40% growth of IMI's seminar division over the past few years. Barbara joined IMI almost 10 years ago and this promotion recognizes her large and consistent contribution to IMI's success.

1990

IMI Establishes Distribution Agreement in Japan. Adept & Company was appointed as IMI's distributor in Japan. "We researched available documentation methodologies in the U.S. and found IMI's to be clearly superior," said Mitsuharu Matsubara of Adept. Adept will expand IMI's penetration of the Japanese market.

Tactics to Distribute in AustralAsia -- Tactics Training Technology, Ltd. was made IMI's distributor to Australia and New Zealand. Business performance"down under" is being greatly impacted by the same information problems experienced in the States. "IMI's methodology is a natural fit with Tactics' CBT and professional services offerings, said Geoff Webb, Managing Director."

Vallone Promoted to COO -- It was announced that Carol Vallone would assume the function of Chief Operating Officer of the Corporation. In their partnership to lead IMI Vallone would primarily focus on internal operations while Gorman develops company positioning and expanded recognition and distribution for IMI's products.

Future Mappers Hatched -- Is Something in the Water? -- Cheryl Gorman and Carol Vallone announced the arrival of children almost simultaneously in early February. Anne Marie Burgess, Manager of Office Services stated that while the water was being checked, there appeared to be no connection between the timing of the births.

1991

Recession Humbles Nation -- IMI growth continues -- Despite the worst recession since the thirties IMI achieved record sales and profits in 1991. "We saw the recession coming," said Gorman "and positioned IMI as a productivity solution for companies undergoing rapid change. He went on to

say that the success was due to the quality of IMI's staff and the focused business planning efforts that were established in the late 80's.

IMI Converts to an S-Corporation -- IMI converted its status to that of an S-Corporation in order to take advantage of the favorable tax status afforded to such corporations. While failing to heed his grandmother's advice that he was "too young to pay taxes", Gorman said that he sought to pay the minimum tax allowed by law.

European Subsidiary Launched -- IMI and Infoware, Aps. announced the creation of a new Corporation, Information Mapping Europe, Aps., headquartered in Denmark to promote distribution of IMI's products and services throughout Europe. IMI cited its partner's understanding of local business needs of the various countries of Europe in establishing the relationship. IMI's goal is for 25% of its profit to come from its international operations within 5 years with the lion's share coming from Europe.

IMI Re-organized -- IMI underwent a major re-organization to permit it to continue its growth through the 90's. Barbara Ross will focus on re-inventing IMI's Information Management Division while Carol Vallone, in addition to her responsibilities as COO, will lead the seminar division's drive to sell at the executive level. Don Sullivan joined IMI to lead IMI's seminar sales and marketing. The change will inject new energy into our Company and allow us to meet the further challenges of the Information Age.

IMI Moves to 128 Landmark -- IMI moved into a Route 128 landmark, the former Nixdorf Building owned by the Nelson Companies. IMI was able to take advantage of favorable real estate conditions and an opportunity in the market to occupy this highly visible building. Congressman Joe Kennedy and Lieutenant Governor Paul Cellucci praised IMI's visionary products and its important contributions to the local economy and community. Gorman proclaimed that, henceforth, the building you can see yourself in as you drive up 128 would be known as "The Information Mapping Building".

1992

50 Instructors Attend Annual Conference -- In welcoming the participants to IMI's annual instructor's conference at the Ocean's Edge Resort, Carol Vallone, IMI's COO, announced that there were more than 50 certified IMI instructors around the globe, most in attendance.

Product Knowledge Systems Launched -- Information Mapping and Precision Teaching and Management Systems announced the formation of Product Knowledge Systems, Inc.(PKS) a Massachusetts Corporation. PKS will offer services related to complex product sets for sales and marketing organizations combining Information Mapping's method, Fluency-Building™ techniques and various templates developed cooperativly with PT/MS.

How High Can It Fly Published -- At the 1992 Instructor's Conference, Bob Horn announced that the Lexington Institute would publish "How High Can it Fly", a compedium of research results of IMI's method.

Worldwide Sales to Top $10 million -- IMI announced that the revenue of IMI, its subsidiaries and its distributors would easily top $10 million in 1992.

Information Management Division Announces Management Changes -- Barbara Ross, Vice President and General Manager of the IMD division announced the hiring of Steve Dorrance as Director of Consulting Services and Steve Gousie, Michael Thames, Bernie Cronin and Pat Scally

as Industry Partners. Ross said that the move positions IMD for rapid and consistent growth in the 90's.

The rest of the story.

1965--Gorman enters 9th grade at Dighton-Rehoboth Regional High School. Vallone passes third grade.

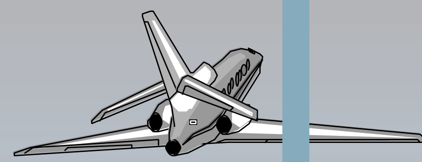
1969-- Mr. Vitale, Head of Guidance at DR tells Gorman that the best he can hope for in life is to go to Bridgewater State College and become an elementary school teacher.

1970 -- Gorman gets D in Freshman English -- In his review of William Shaekspeare's Romeo and Julliet. Gorman's book report showed early promise as a mapper by reducing thestory to block label "The boy liked the girl". Vallone kisses her first boy "says he needs to improve results."

1971 --Vallone elected class president.

1973 -- Vallone gets driver's license Gorman goes to work. Begins burning money for the Federal Reserve Bank, a skill that he would perfect later in his career.

Research on Structured Writing by Others 1997



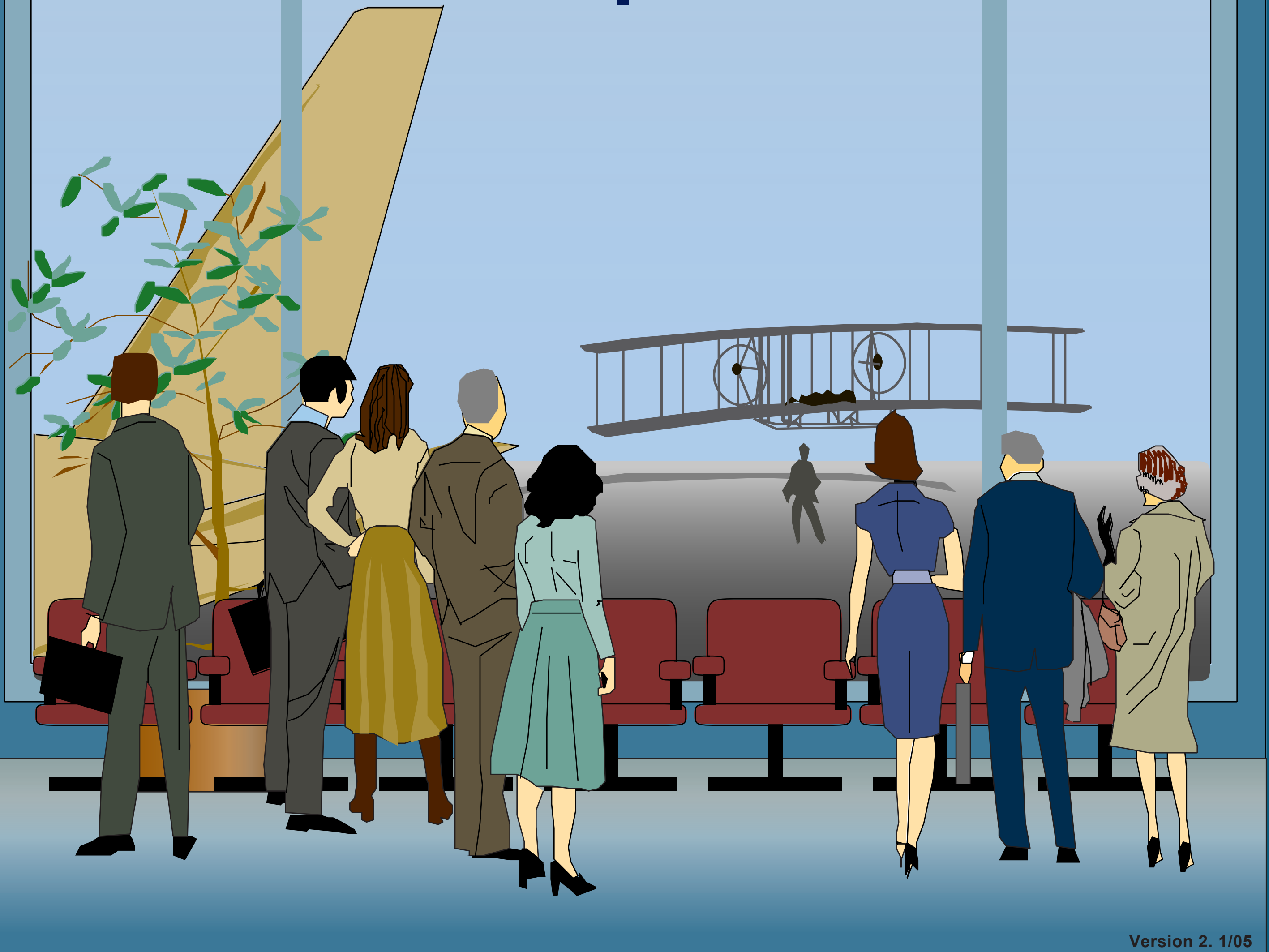
How High Can It Fly?

Examining the Evidence on Information Mapping's Method of High Performance Communication

by

Robert E. Horn

Chapter 1



Version 2. 1/05

Table of Contents
Chapter 1

Table of Contents
Chapter 2

Note
If you do not have Chapter 1 or 2, please download it from:
http://www.stanford.edu/~rhorn/a/topic/stwrtng_infomap/tocStructrdWriting.html

Overview of Research Results

Introduction

When evaluating a methodology such as Information Mapping's method, it isn't a good idea to ask "Is it a good thing?" and expect to get a simple "yes" or "no" answer.

That is an unsophisticated view of evaluation. You wouldn't ask that of a large truck or an automobile. You would use the kind of approach used in consumer report magazines. They break down the question of "Is it a good product?" into several questions. Similarly, managers need to ask a series of questions about the methodology that Information Mapping has developed.

Basically, the approach is to first, look at the purpose(s) for which the products are used; then, establish a set of criteria by which to judge the product; and finally, develop some kind of matrix of results from which to make your final decision.

On this page, we list the questions managers should be asking about Information Mapping's method, and provide the page numbers in this chapter where the answers can be found.

Major Questions in Evaluating Information Mapping's Method

Questions About Effectiveness

- Effectiveness: Does it work at all? Can people learn from this system? Can they use it for reference work? (See p. 6)
- Comparative Effectiveness: How does it work compared to other approaches? (See p. 8)
- Business Effectiveness: How well does it work in real world business situations? (See p. 10)
- User Acceptance: Do users like it and use it? (See p. 12)
- Teaching Effectiveness: Can you teach it to others consistently? (See p. 14)

Questions About Use

- What other operating characteristics do you find? (See p. 16)
- Does it work under difficult conditions? (See p. 18)
- Scaling Up and Scaling Down: Does it work on large as well as small projects? (See p. 20)
- Does it work in very constrained situations? (See p. 22)
- How good is it in routine updating and maintenance? (See p. 24)
- Does it work in special training situations? (See p. 26)
- Besides all that efficiency and effectiveness, can you provide an attractive and comfortable journey? (See p. 28)

Questions About Cost/Effectiveness

- Does it increase productivity? (See p. 30)
- Is it cost-effective for its mission? (See p. 32)

Other Evaluation Questions

- How do you evaluate the parts and subassemblies? (See p. 34)
- Can you measure critical variables in its components? (See p. 36)
- Can you do creative things with it? (See p. 38)
- Will it aid in discovery of design flaws in other parts of the process? (See p. 40)

Interlude-The Aircraft Evaluation Metaphor

Introduction
We can look at the question of this chapter: "How do you evaluate something like Information mapping's method?" by a parallel examination of an analogous question: "How do engineers test and evaluate a new airplane?"

Component Testing and Assembly
When engineers design an aircraft, they use the best components. They make sure that each one of the components has been tested and evaluated by its manufacturer. And they test their own quality control and assembly line methods. Similarly, when we developed Information Mapping's method, we found the best components for our method. We didn't invent all the components, nor did we do all the research and evaluation on the components. We were highly selective in our synthesis. Ant we put all of the components together to meet our high criteria of performance. For example, decision tables had been invented in the computer industry a few years before. They looked promising as a tool for analyzing and communicating decisions. After our own testing, they became one vital component of Information Mapping's method.

Using Components to Support Mission
Aircraft designers don't invent a generalized aircraft. they invent an aircraft to accomplish specific missions: one that has to fly a specific distance and carry a specific number of passengers. Then they select components to do that job.

Similarly, we didn't use everything that was available in the world of communication. For example, there are many communication techniques which are effective in advertising but which are not appropriate in other arenas of business.

We identified the best components available for the purposes of clear, consistent, and precise communication in specific kinds of documents.

Testing Performance
After an aircraft has been designed, a test pilot flies it. Can if get off the ground at all? Evaluators want to see if the components, each of which have been tested separately, perform together. How fast does it fly? Evaluators want to know how much maintenance it needs. Similarly, we tested our method in hundreds of different situations.

Testing Cost-Effectiveness
Just because engineers can build an aircraft doesn't mean that it is cost-effective. They have to do a different kind of analysis to answer the question of cost-effectiveness.

Similarly, we have compared the cost of producing documents using Information Mapping's method for various kinds of tasks, from writing memos and reports through writing large documents and training systems and research reports.
And our users have found that it is extremely cost-effective.

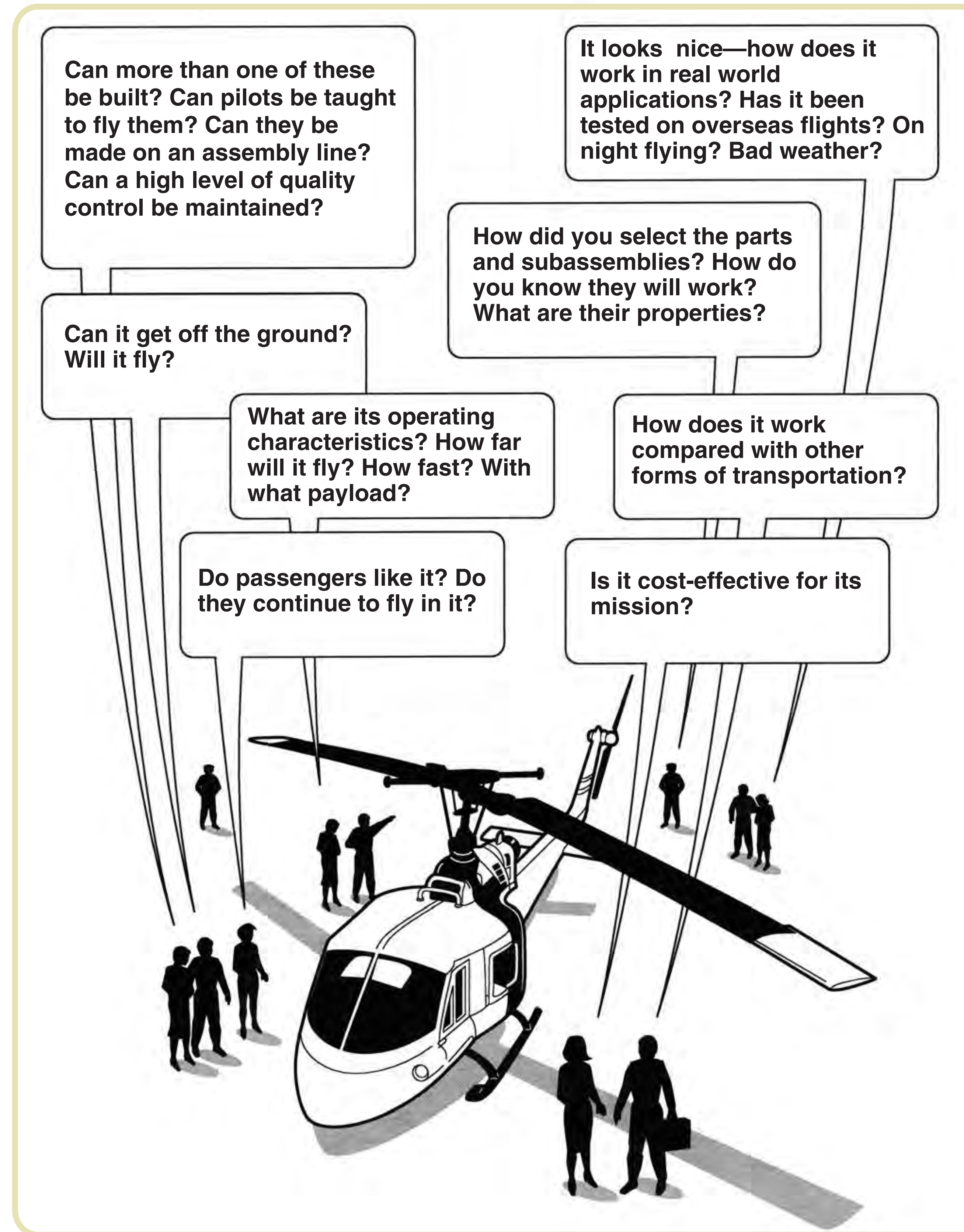
Using Scientific Theory
It should be remembered that an important part of making an aircraft fly is aerodynamic theory-the science of flight. The Wright Brothers made a plane fly without the benefit of very much aerodynamic theory. Therefore, their first aircraft did not fly very far and did not go very fast. In fact, it flew for twelve seconds the first flight. It flew three more times that year and then was destroyed in a crash.

Early in our development of documentation engineering (before we had the theory to guide our design efforts), we too had a few crashes and produced documents that couldn't get very far off the runway. But, over the years, improvements in Information Mapping's method have made major contributions to the theory of modern training documentation, enabling us to have consistently high performance communication.

Comment
So, in many ways, we have looked at the evaluation of Information Mapping's method in the tough-minded way an aircraft engineer judges an aircraft. We will look at many of these questions in the coming pages and see how analogous questions can be asked of Information Mapping's method.

Note on the Engineering Metaphor

We use the method in this chapter to emphasize the seriousness with which we approach the issues of communication. We are serious when we ask, "If your documentation writers built an aircraft, would you fly in it?" We believe that the subject of documentation can and should be "engineered" with all the precision and professionalism of aircraft engineering.



Effectiveness: Does it Work?

A Course at Harvard
Only a couple of years after I had first formulated the ideas for Information Mapping's method, Harvard University's Graduate School of Education asked me to teach their course, Research in Instruction. Dr. Douglas Porter, who usually taught the course, encouraged me to teach Information Mapping's method to the class as it applied to developing instructional materials.

Initial Question: To What Can It Be Applied?
I was eager to teach the course on Information Mapping's method because it would begin to answer the question: "Does it work at all?" One aspect of analyzing the effectiveness of the course was: "Can it be applied to a wide variety of subject matters, or only to a limited few?"

At that time, I had tried the method on about a hundred pages of computer software documentation, and had written a few pages on several other subject matters. Because of the way the methodology was put together, I was fairly confident that it would work with many subject matters. But I didn't know just how widespread its applicability would be.

15 Different Academic Subject Matters
Teaching the Harvard class gave me a chance to talk with people from varying academic backgrounds. The range of their specialties was wonderful. There was an art teacher, a statistician, several social scientists, several people from the sciences (biology and physics), a recent graduate from the Harvard Dental School who planned a career in dental education, and a mathematician. "This will provide a very good test," I thought, "as to whether or not you can apply the method to a lot of different subject matters."

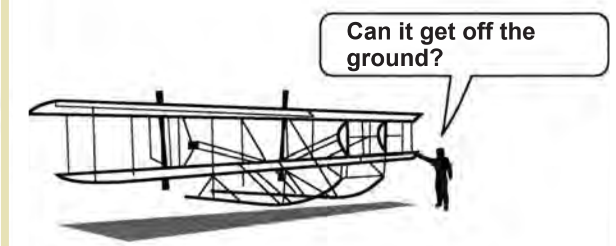
All Areas and Grade Levels Successful
Shortly after I asked the students to write a paper using our method in their own individual subject matters, there was a great deal of excitement, and it became clear that their projects were working. I had successfully taught Information Mapping's method to a group of people for the first time. The students were turning out instructional material using the method, and their students, colleagues, and friends liked using it. The method had passed the first hurdle.

Now, Almost All Business Subjects Tested
The same question, "How many subject matters will the method apply to?" has now been more than adequately answered.

It has been applied to literally thousands of different training and documentation situations in industry: clerical, professional, technical, and managerial. It has been applied to computers and it has been applied to assembly lines. Information Mapping's method can be applied to an extremely wide variety of situations successfully.

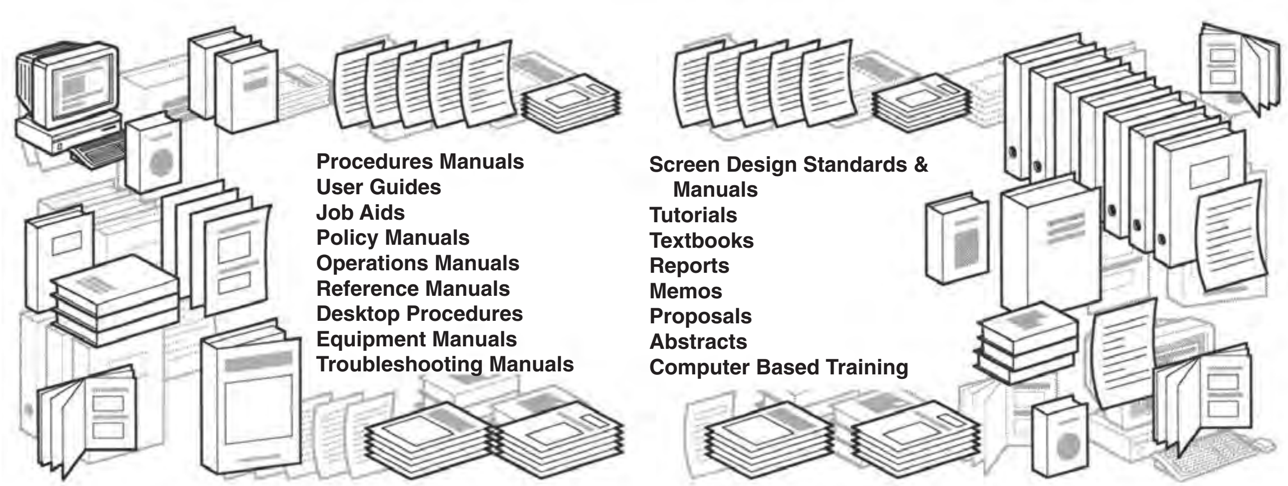
Analogy to Aircraft Evaluation

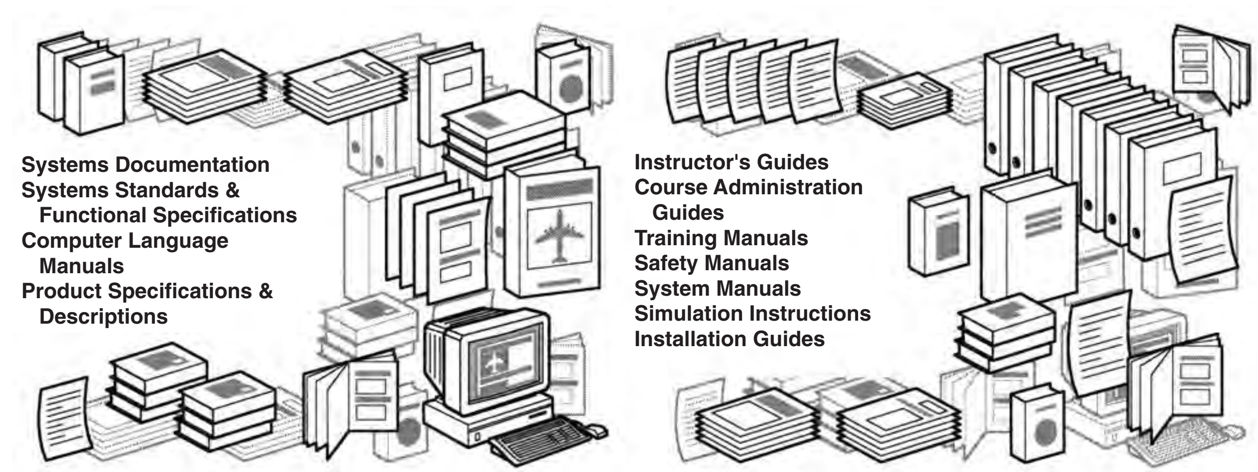
Their "does it work" question is analogous to the Wright Brothers' question:



Information Mapping's method "gets off the ground" with every major document type in business, science, and technology.

Select Document Types for Which Information Mapping's Method Has Been Used





Comparative Effectiveness: How Does It Work Compared With Other Approaches?

Introduction
When we started working on Information Mapping's method, we surveyed the research on improving human communication and incorporated the best of that research into our design. But, after we'd put it all together, the question remained: "How does it work compared to other approaches?"

Fifteen Dissertations
Over the past 15 years, 15 major dissertations have been completed on Information Mapping's method, several master's theses have also been completed, and more research is in progress. These projects have been done in four different countries: the United Kingdom, Canada, the Philippines, and the United States.

User Populations
The studies involved a variety of different students, from high school to university and college students, adult learners, and clerical workers.

Compare Prose or Programmed Instruction
Eight of the studies compared Information Mapping's method with some other method. The most common was to compare it with conventional prose text. Some of the early studies compared Information Mapping's approach with material that contained short chunks of text with many carefully sequenced questions called programmed instruction.

Compare Learning and Retrieval
Some of the research studies compared two treatments from the standpoint of learning (measuring errors and time to learn) while other studies compared the ability of people to retrieve information from a document in job-like circumstances. Retrieval tests were done because much of the learning that goes on in the business and industrial environment is related to on-the-spot performance, which requires the learner to go to a shelf of manuals, texts, or training materials and look up what they have forgotten or perhaps what they have never learned in the first place.
It has been estimated that more than half of the learning that takes place in business and industry is of this reference-based type.

Summary Conclusions
The comparative studies showed that Information Mapping's method was significantly superior to the more conventional methods. In Chapter 2, we summarize each of these studies. Here are some highlights.

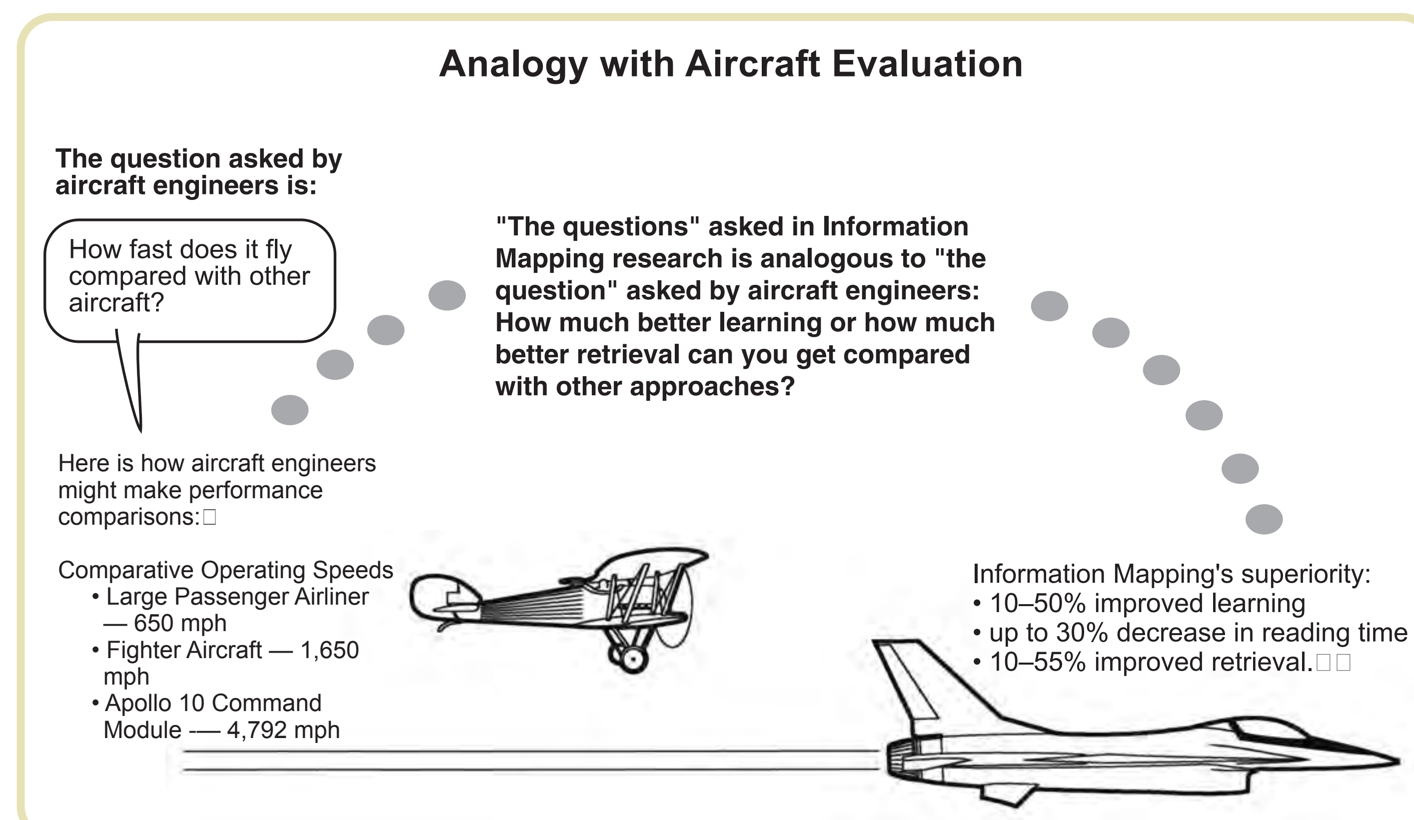
Effective with Low Ability Adult Learners
Michael Stelnicki of Northern Illinois University found that the text written with Information Mapping's method was more effective for learning facts and concepts than standard text materials. Stelnicki did his study on subjects who were in the "low general ability category."

Retrieval is Better
David Jonassen, of the University of North Carolina at Greensboro, and Lawrence Falk reported that the structural characteristics of Information Mapping's method provide a clear advantage for retrieving information from textual materials. Jonassen and Falk's study compared the retrievability of information developed according to the Information Mapping standards with that of training materials with strong characteristics of programmed instruction.

Many other studies of human memory show that learners forget up to 80% of what they learn within two to four weeks. That means that all of us must go back to the textbooks that we used in class to look up what we need to know when we have to use it on the job. And this is where the superiority of Information Mapping's method for retrieval is most important.

Children and Adults Learn Mathematics Faster and Better
Alexander Romiszowski of the Loughborough University of Technology in England compared Information Mapping with traditional textbooks in a mathematics course. Subjects were 15- and 16-year-old advanced secondary students and 20- to 30-year-old adults who were attempting to complete high school. Romiszowski reported that Information Mapping's method enabled students to learn significantly more mathematics in less time than students using traditional textbooks with comparable subject matter.

Significantly Higher Achievement in Initial Learning
Thomas J. Soyster of Temple University compared the use of the Information Mapping materials with ninth-grade vocational education and science students. He found that students who used Information Mapping's method scored significantly higher than those who used programmed instruction materials when tested immediately after the training.



Business Effectiveness: How Well Does it Work in Real World Business Situations?

Business Results Better Than Academic Results
How do the academic results reported on the previous page transfer to business situations? Do business evaluators find similar results in their real-life training situations? The answer has been surprising. Frequently, the results are even better!

One of the earliest reports of a major evaluation was done at Pacific Bell. They compared Information Mapping's method with their standard training procedure.

Improves Initial Learning by 50% and Reduces Training Time by One-Half
Naomi Webber of Pacific Bell has reported on an evaluation of a two-and-one-half day course for clerical people on accounting coding tasks. Her report, presented at the convention of the National Society for Performance and Instruction, indicated that learners using materials written in Information Mapping's method scored almost twice as well on the criterion test as did the control group. The Information Mapping learners took an average of one day for the self-paced learning mode as compared with two days for the control students. Ninety-five percent of the Information Mapping learners felt "fairly well" to "well prepared and confident" at the end of training, as compared with 44% of the control group.

Webber reported, "The performance level back on the job has been good. We've seen them start out making 85% accuracy, and within a month they're moving up into the 90s in on-the-job performance."

Industrial Strength Test under Real World Conditions
Academic studies, while very important, are often conducted with training materials that take about an hour to learn and have relatively few pages. People in ordinary business situations, however, have to process gigantic amounts of information. Eric Shaffer used a large 185-page manual prepared by Information Mapping, Inc., for his research. Clerks had to use this manual to look up and understand complex information in order to fill out forms. He compared the effectiveness of this version with the standard 140-page manual that was in ordinary use in the company (unfortunately, the name of the large telecommunications company which sponsored this research must be withheld because of non-disclosure requirements). Shaffer said in his report that Information Mapping's version had "few errors in content and an exceptionally clear writing style." Informally, we were told that a special task force had considered it to be one of the best manuals ever produced by the company.

Shaffer's test subjects were employees of the company who were going to use this manual on the job, not students as in academic studies.

Results of Performance Study
When using the Information Mapping version of the manual, the subjects committed almost 55% fewer errors than with the standard version. So, when up against the best manual produced in the company, Information Mapping came out far ahead.

Licensing the Method
Shortly after these and other evaluations were done, Pacific Bell became the first major company to obtain a license to teach Information Mapping's method. Since then, many other companies in the Fortune 500 have licensed the teaching of the method for their employees.

Importance: Much Office Work Is Error Correction
The importance of these studies should not be underestimated. Marvin Sherman, a Cambridge, MA–based office procedures and office automation specialist, reported that 50 to 60% of the work done in an average data processing office is the correction of errors; in fact, a great many of these errors are due to improper training and procedures.

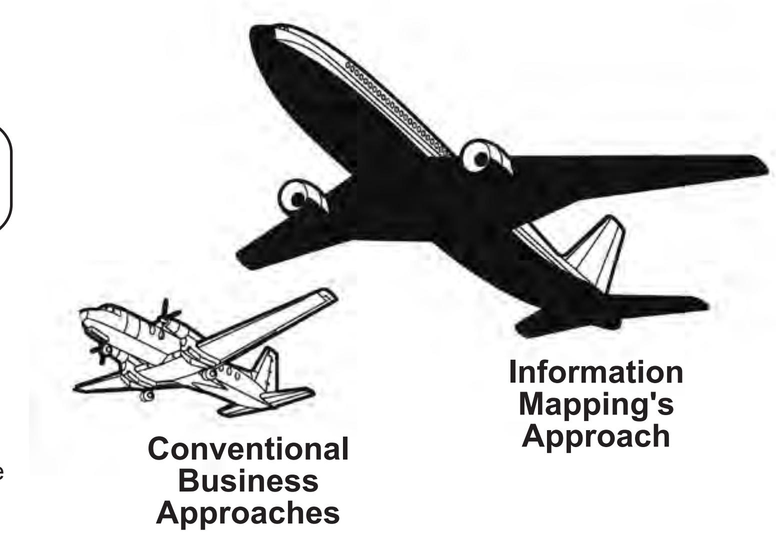
Analogy with Aircraft Evaluation

The question asked by aeronautical engineers is:

How well does the aircraft perform compared with other business aircraft?

The question asked of the Information Mapping approach is similar: "How does it work compared with other approaches?"

Business report 10 to 50% more rapid writing of technical documents.



User Acceptance: Do Users Like It and Use It?

Important Question: Do People Like It?
Do people like Information Mapping's method well enough to use it regularly? The answer to this question is that Information Mapping's method has been receiving recognition and acceptance from the time of its first experiment to the present.

Test In Statistics Class
Early in our research, we directly tested this vital question of usage with some students in statistics at the Harvard Graduate School of Education. We wanted to find out if there was simple acquiescence to using the method, or if we had something that people really wanted. We figured that if a busy student would make a special trip and walk a few blocks to get the material for review, it would say something very positive about their acceptance of the method.

We had done the usual control group learning experiment, giving half of the class a straight prose version, the other half Information Mapping's version. The students spent an average of 10 hours with the different versions and took open book midterm exams. At the end of the test, we collected all of the learning materials that they had been using. Then they went back to using their regular textbooks for the rest of the course.

Learners Can Have Own Copies If They Walk to Our Office
We announced after we picked up the books that anyone who wanted a personal copy of the textbook materials used in the evaluation could come over to our office and get their own copy.

We wanted to count the number of people who would take time out from their busy academic schedule to get a copy of something they had already learned from and had already taken the preliminary test on. We felt it would tell us they liked it well enough to walk six blocks out of their way.

When they came to the office, we offered them a choice of the two different versions--the prose version or Information Mapping's method version. It was the first time they had a chance to examine both versions.

Most Chose Information Mapping's Method
Thirteen students walked the six blocks. After inspecting the two versions, 12 of the 13 students selected Information Mapping's version. This type of evidence for preference is particularly strong because it relies on behavior rather than verbal reports.

Pacific Bell's Pilot Study
Pacific Bell in San Francisco was one of the earliest companies to license the Information Mapping methodology. Before committing the company to a long-term license, Pacific Bell decided they would do a pilot study first. Because they wanted to avoid "shoving it down anybody's throat," they had a couple of trial courses, and then sent out an announcement of the courses with their regular course bulletin.

Overenrolled Each Time
At the time this study was conducted, the managers could choose which courses their employees needed. Clearly they couldn't buy every course they needed: the time wasn't available and the training budgets were limited. The managers' response at Pacific Bell was, however, to overenroll the course by twice the available seats! This meant that managers were willing to pay out of their own training budgets to have their people trained in Information Mapping's method. Several thousand people have now taken the course at Pacific Bell and the course was frequently oversubscribed for many months. This experience proved that Information Mapping's method satisfies very tough criteria: "Do they want to use it when they don't have to?" And "Will they pay for it out of their own budgets?" The answer to these questions appeared to be a resounding "yes."

Analogy with Aircraft Evaluation

Do passengers like flying in it? Do they continue to buy tickets?

The questions here are, "Do readers and writers like it and continue to use it? Do people prefer using Information Mapping to other systems? Do you have repeat business? Do customers want to license the technology?" They are similar to the market research questions in the airline industry.

Information Mapping's customers have grown each year and averaged 10,000 seminar attendees the last few years, many as a result of referral and most from organizations who had been clients before.

Many large organization have licensed the teaching of the method so as to teach hundreds of employees a year more economically.

Teaching Effectiveness: Can You Teach It to Others Consistently?

Important Question: "Can You Teach It?"
One of the important questions that we need to face in having a successful writing methodology is, "Can we teach writers?" Here are some of the most important questions we need to ask in order to determine whether the writing methodology is successful:

- Can we teach writing with some assurance that writers can or will follow standards?
- Would two or more of our trained writers deal with the same subject matter in a similar fashion?
- What implications does use of the method have for the management of large writing teams?

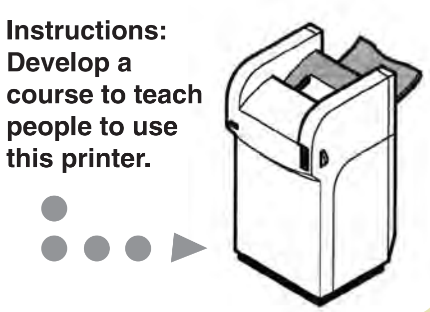
Our investigations into these questions have produced very encouraging results.

The Research Protocol
We teach dozens of courses a month in writing procedures and instructional manuals. In each of those classes, we have given a standard exercise to every participant at the end of the course. We expect that they will create seven maps, all of the right type, select and write the correct blocks, and that all will have a similar organization and sequence to the chapter that they have written. A description of this evaluation follows.

Time and Groups
The learners spend approximately four to eight hours on this exercise. They typically work in groups of two or three, although some individuals work alone.

Input
The learners are given dialogue and drawings about how to run a piece of equipment (in this experiment, a printer from a data processing system). They are asked to develop a short project of documentation on the subject based on the information provided.

Instructions: Develop a course to teach people to use this printer.



Outcomes
Our instructors thoroughly examined the results of this test in every class, and we found approximately 80% or better similarity in all the maps and blocks in every class.

If we did a formal evaluation, of course, we would scramble the pages, and ask independent judges to determine who wrote which page. The judges, we are confident, would be unable to tell who wrote which pages; they are so similar.

Moreover, the judges would find that 80% or more of the different treatments were functionally identical (with minor variations in wording).

Conclusion
These are impressive results. They mean that properly trained instructors can reliably teach people to write in Information Mapping's method. And we have been doing it in our classes with certified instructors since the late 70s.

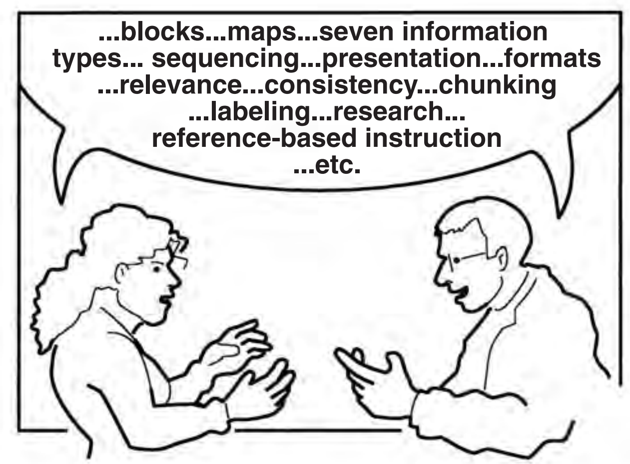
Basically, this ongoing quality control process means:

- the method can be taught
- it can be taught to be effectively used immediately
- the way it is implemented by wide variety of people is remarkably similar.

This does not mean, however, that you cannot employ your creativity when using Information Mapping's method.

Writers Have Common Language About Writing
One of the most exciting aspects of Information Mapping's method is that we have developed a common language writers can use to talk with each other about their craft. It is now possible for writers halfway around the world to contribute chapters or pages to a common project and have the outcome of their diverse contributions be easily combined into a common product.

Before, when one writer talked to another and said, "Well, you need a paragraph here," there was no predicting what you might get. Different writers would write many different things. This, however, is not the case with Information Mapping's methods with which writers tend to approach the same subjects with a highly reliable similarity. For obvious reasons, this similarity is a great advantage when dealing with business documents.



Two Courses Written-Unable to Tell Who Wrote Which
This remarkable similarity of documents produced with Information Mapping's method was proven to me when I taught a course in England which Alexander Romiszowski, the well-known British instructional designer, attended. After the course (though neither of us was aware of it) Romiszowski and I were simultaneously developing courses on matrix algebra.

A year later, he sent me a copy of his course, and I recognized immediately that we had conducted an extraordinary experiment. We had each used the same method to approach the same subject matter completely independently of each other. In the language of research design, we were perfect controls for each other. We were the perfect blind experiment!

Results
The results were beyond my greatest expectations. We found a remarkable similarity in:

- choice of subject matter,
- division of the subject matter into maps and blocks, and
- treatment of various blocks.

If we had wanted to do a formal evaluation, we could have scrambled the pages that each of us had written and challenged a judge to determine who wrote which page. In such a case, it would have been nearly impossible to tell which version the pages had come from. This case illustrates the remarkable ability of Information Mapping's method to achieve one aspect of high quality control standards: substantially similar courses.

Analogy with Aircraft Engineering

The aeronautical engineering questions are:

- Can you build more than one of these?
- Can you teach pilots to fly them?
- Can these be made on an assembly line?
- Can you maintain a high level of quality control?

The documentation questions in quality control are:
- Can the method be taught?
- How easily can a group of documentation engineers and technicians work as a team on documents?
- How do you maintain quality control?

The results of weekly quality control tests are resoundingly positive.

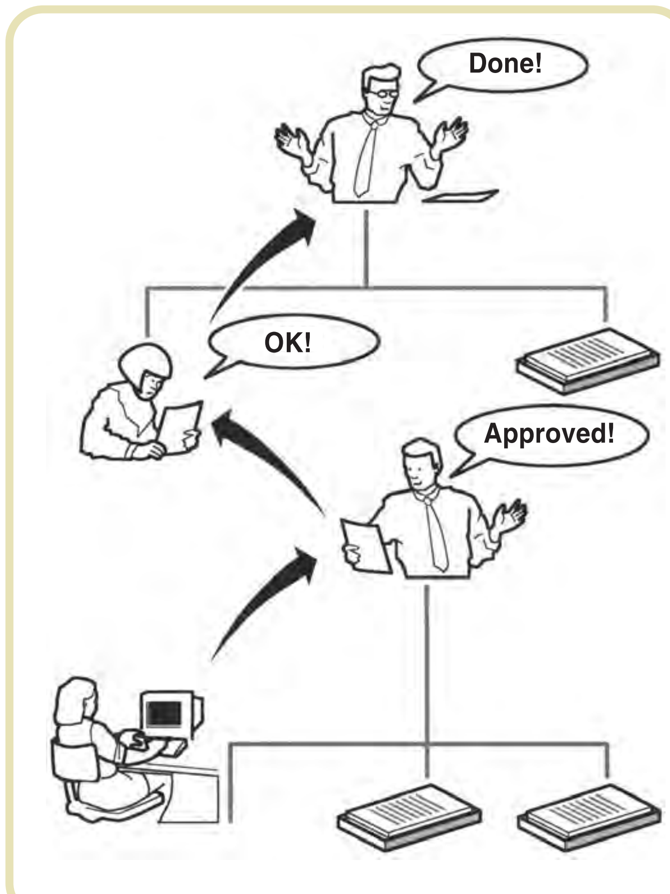
What Other Operating Characteristics Do You Find?

Test Pilot Takes the Method Out for a Test Flight
One of our test pilots was Sarah Bixler of Lincoln National Life Insurance Co. She presided over the installation of Information Mapping's method for writing reports, proposals, and memos in a whole department. At a National Society for Performance and Instruction meeting the following year, she reported on her experiences, and provided some valuable insights into the operating characteristics of Information Mapping's method. We quote some parts of her report on these pages to give you a taste of the unexpected benefits that managers receive from the method.

Increased Project Control
"I'm a project manager and I'm supposed to have a lot of autonomy when I do my job. But there are always those points when you have to get some kind of an endorsement from somebody above you. And I found that when I went for those endorsements, the people were playing around with my projects, and I was losing control. I couldn't really determine why that was happening, but I knew I had a problem. When I went through Information Mapping in report and memo writing and started using the decision memo that's outlined in that course, I found that I stopped having the problem because I was asking very open-ended questions when I was getting my endorsements instead of saying, 'Here's the problem, here are the alternatives, here's my recommendation, what's your decision?'"

More In-depth Thinking
"I think when you first approach Information Mapping, you think of it as a way of writing. Then, after you've worked with it for a while, you think of it as a way of thinking. And so, the second benefit is that we find it actually facilitates more in-depth thinking about the subject matter itself. Then, after someone has written a memo in Information Mapping, they're very likely to say, 'You know, I hadn't really thought this much about that subject beforehand,' or, 'I really came to some good ideas that hadn't occurred to me before,' or, 'I really thought about a facet of the problem that I hadn't been able to think about before.' So it's actually facilitating in-depth thinking about the subject they're writing about."

Faster Response Time
"A third benefit that we didn't expect is a faster response time. I'm sure that a lot of you are in organizations where, if you're having a problem, it seems like it takes forever for anybody to even get to the problem to help you. I was working on an interdepartmental project. The department that I was working with promised to have it for me by a certain date and then they told me that they weren't going to be able to meet their deadline. Well, I had already committed to that project, and I was very concerned about it. I put together an Information Mapped memo about the problem that I was having and asked for assistance. I left it on my supervisor's desk before I went home one evening, and the next morning when I got to work, it had already gone up three levels of management and was ready to go to the head of the other department. I've never had that kind of response time for any problem I've had before. "



Better Utilization of Clerical Staff
"The fourth benefit is to our clerical staff. I have found that our clerical staff has really responded very positively. I think that we were underutilizing them. We weren't giving them enough responsibility for drafting letters and memos themselves. I don't know if that's a common problem with other people in other companies, but I felt that we needed to give them more responsibility.

"They were a little bit shy about taking that responsibility, but after going through the workshop right along with the other managers and staff people, they have really done some super things. They have been drafting their own letters for the first time, and they're very proud of them.

"One person who is responsible for coordinating our home office schools has a whole series of memos she sends out beforehand that have been traditionally written by a staff person. They have traditionally been very hard to read, so she's taken that whole series and rewritten all of them on her own, and they are terrific. She's done a really good job with it. So they've seen it as a way of actually increasing the kind of responsibility that they're dealing with. And I think they were very excited about being included. "

Better Meetings Because of Better Pre-Meeting Report Preparation
"The fifth benefit that we didn't expect is the way an Information Mapped memo or report can actually help a task force or committee stay on track. My supervisor is involved in a task force for developing a feedback system for our work effectiveness program. He needed to put together a report that would identify the problem and name some different recommendations and possible solutions. He did the report in Information Mapping.

"He spent quite a bit of time thinking about the subject. In fact, he said he may have spent longer than he would have writing a memo in the traditional manner. When the other members of the task force got it, though, they went through it, asked a couple of questions, turned to his recommendation page, and were able to use it as an agenda.

"They anticipate that it may have reduced the time that they had to spend together as a committee and task force by at least 10 hours. That more than offset the extra time that he put into preparing the memo because of the thought he gave before going to that task force."

Analogy with Aircraft Engineering

After engineers have designed an aircraft, they have a test pilot fly it to see how well it performs its intended function. They want to see how fast it flies. They want to see if the components, which have each been tested separately, fit together properly. And often, they want their test pilot to observe and report on operating characteristics that might not be easily subject to precise empirical investigation or testing in their wind tunnels.

Does It Work under Difficult Conditions?

Introduction
The real world of business has many situations that don't fit into neat academic research categories, and there are many rough edges which academic research tends to smooth out in order to control all the variables. For this reason, it is often much more difficult to do research in the world of business than in the controlled conditions of an experiment.

The Questions To Be Asked
In the world of business, we address our methods and materials, asking, How well do they work:

- in actual training situations?
- presented on-line on computer screens?
- when there are thousands of pages of documentation or training materials?
- with those who have poor English reading skills, or who only speak English as a second language? with hotshot experts? For supermanagers?

Information Mapping's method has been tried in literally thousands of business situations. The chart on the facing page lists some of the many types of tough situations for which the method has been used and found to be robust and successful.

Large Application Situations
One of the largest real world situations (we happen to know about it because we did it) involved the documentation of over 3,000 pages. Using Information Mapping's Method, the documentation was done by a team of 5 people in 8 months, with only one and one-half drafts. The material was then successfully used in the implementation of the largest computer system ever installed by one of the top petrochemical firms in the world.

Analogy with Aircraft Evaluation

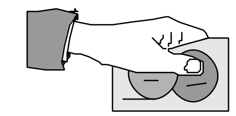
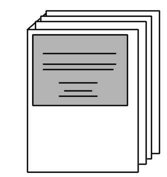
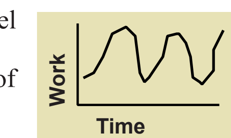
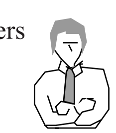
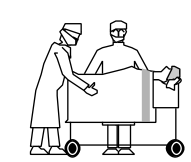
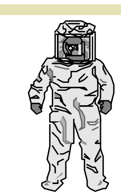
In our continuing analogy to aircraft engineering evaluation, we would compare the questions we are asking on this page to the aeronautical engineering questions:

- How does it work in real world situations?

  - Has it been tested on overseas flights?
  - What about night flying?
  - What about flying in bad weather?

Information Mapping has been tested in many very difficult situations. See chart on facing page.

A Sampling of Difficult Real-World Situations

Context	Requirement		Unusual or Difficult Circumstances
Gigantic projects Impossible deadlines	Write approximately 3,000 pages of documentation and training		- new computer installation - 1,000 people to be trained over a 3-month period
Instructor not present	Train retail clerks to run credit checks		- personnel must train themselves because there are stores in many different locations
On-line database of drug evaluation information	Design database for information system		- information must be easily accessible to physicians and health personnel - must be easy to update weekly
Impossible deadlines 	Document personnel policies (over 1,000 pages)		- five months to write entire manual using 40 subject matter experts and team of 5 writers
Procedures for clerical personnel	Document back office business procedures for large financial institutions		- high turnover of personnel - large backlog of work - many peaks and valleys of work flow 
Hospital administration	Train busy hospital personnel to run new computer		- little time for training - much self-instruction required
Experts as Learners 	Write computer manuals for programmers in a computer company		- users think they already know everything about the subject
Physicians as learners 	Design medical reference system		- physicians reluctant to touch keyboards - too busy to learn system
Chemical plant safety	Train chemical plant employees (at all levels)		- safety is critical to the operation of plants when highly toxic or explosive materials are used
Non-fluency in English	Train clerks in a retail store environment		- English is a second language for trainees

Scaling Up and Scaling Down: Does It Work on Large as well as Small Projects?

Introduction

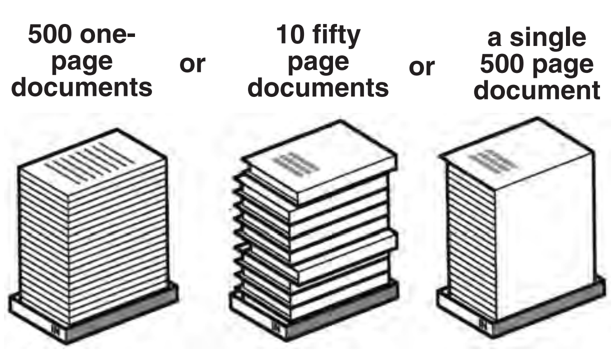
When you have a systematic approach to tasks, it is always good to ask: "On what scale does it operate?" and "What are the limits of its applicability?" Information Mapping's method has performed well with both very small and very large documents.

Smaller Writing Projects

Information Mapping's method has proven to be very useful in smaller documents such as short reports, memos, and proposals. These documents are the lifeline of day-to-day business communication. Informal evaluations suggest that this clarity of communication is invaluable from the standpoints of both the reader and the writer.

From the Reader's Standpoint

If you think about it, it makes little difference to you if your in-box is filled with ... 500 one-page documents, or 10 fifty-pagers, or a single 500-page document.



It does make a difference if most or all of the reports and memos contained in your in-box are written using Information Mapping's approach.

If documents follow Information Mapping's approach, they are much more scannable. Managers or technical persons can then prioritize their reading much more easily, and find the critical information much more rapidly. They can skip the unessential or irrelevant, and what they already know.

The lesson is that 10 fifty-page documents add up in complexity to one 500-page document. For this reason, using Information Mapping's method on smaller documents can be as effective in decision-making and time-saving as it is in a large document.

Largest Projects

We have also seen Information Mapping's method applied to very large projects. Here are some of the largest projects our staff has done.

Type of Document	Measurement
Paper Documentation	3,000 pages
Training Course	six weeks, 8 hours per day
Online Documentation	several thousand screens
Online Reference	answers to over 10,000 questions

Results: Upper Limits of Size Not Yet Reached

After surveying our project managers and our clients, we can say that we believe that we have not reached the size limits of the Information Mapping method. The method appears to get better the larger the document size. Since the method was designed to handle complexity, it appears to have met its overall design objectives in this regard. How do principles and theory apply when scaling up or scaling down (i.e., how would they apply to the design of very large and very small aircraft)? What is their comparative effectiveness in these different scales?

Scaling Up, from the Writer's Standpoint

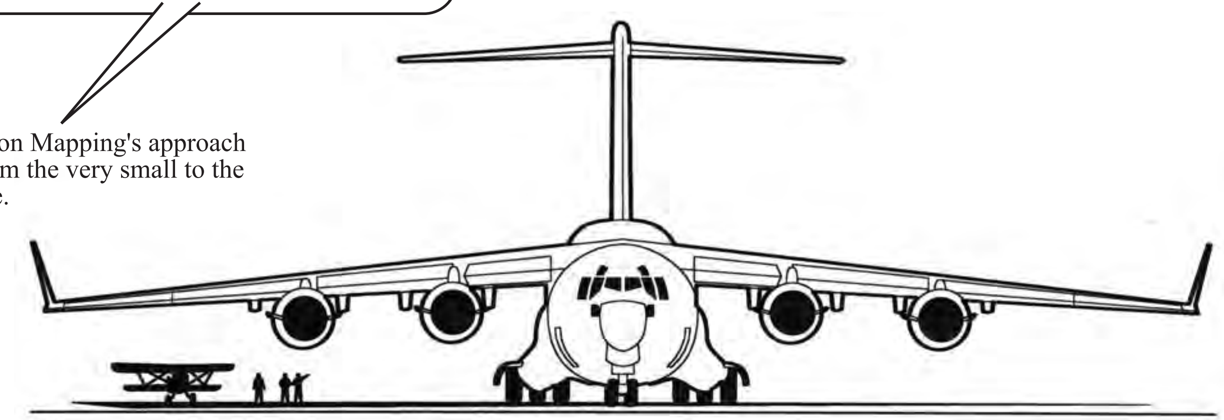
One of the lessons that we have learned in teaching 10,000 people a year to use Information Mapping's method is that our schools and colleges do not have a successful, systematic method for helping people handle the major problem of writing beyond two or three pages. That problem is organization. People are not taught to analyze and organize a document over 2 or 3 pages. Unless they've had a good course in report writing, a good coach, or plenty of native talent, most of them have no real means of sequencing subject matter effectively.

Analogy in Aircraft Engineering

The questions that an aeronautical engineer would ask in this situation are:

How do principles and theory apply when scaling up or scaling down, i.e., to the design of very large and very small aircraft? What it their comparative effectiveness in these different scales?

Information Mapping's approach works from the very small to the very large.

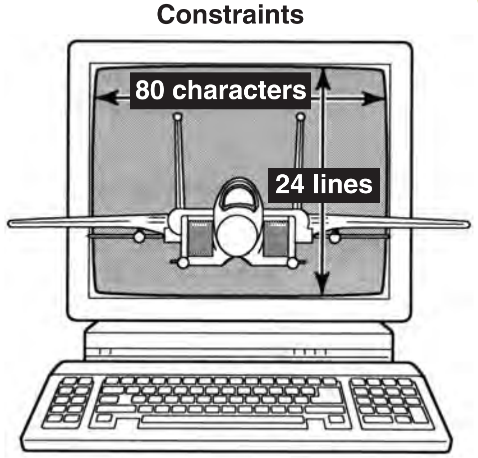


Does It Work in Very Constrained Situations?

Introduction
Information Mapping's method was initially designed for the development of many different kinds of paper documents. In the last few years, many documents have begun to be stored and displayed only on the computer screen. A logical evaluation question is: "How well does the method work on the computer screen?"

Constraints of the Computer Screen
Most of us are well acquainted with the constraints of the computer screen. First of all, most screens are too small to do a really good job of displaying learning and reference material. The average size page is a much better display area. Furthermore, computer screens are often harder to read than the printed page.

Constraints

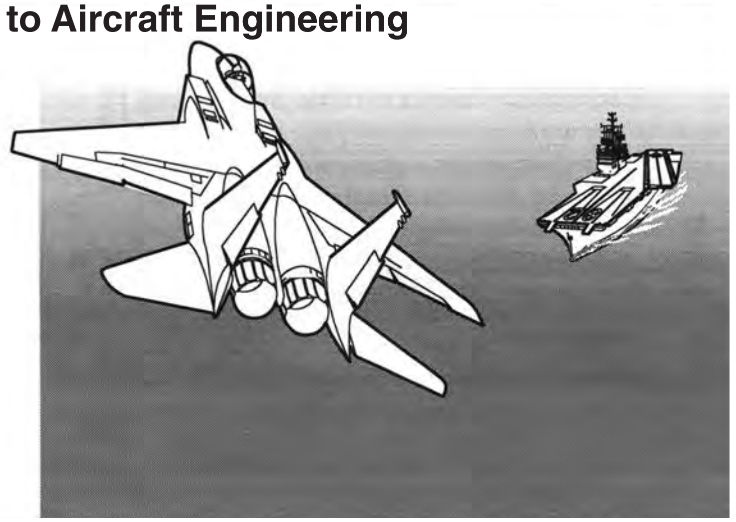


The Method Works Better Than Other Forms of Writing
The answer to questions about the effectiveness of online text is that Information Mapping's method works very well, certainly better than any other methods proposed to date. A major reason is that the method uses the precisely defined information block which fits on even the smallest screens. Thus, one problem is solved. An adaptation of the block labeling and map-titling techniques of Information Mapping's methodology permit the design of screens that prevent most forms of cognitive overload and the problem of being "lost in cyberspace."

Analogy to Aircraft Engineering

A comparable aeronautical engineering requirement for working in very constrained circumstances might be:

Can an aircraft be built that can land regularly on an aircraft carrier that looks about the size of a postage stamp, bouncing around in the ocean waves?



Information Mapping's approach has worked in constrained situations very well.

Some Typical Applications of Information Mapping's Methodology to Online Text

Type of Project and Application	Client Organization	Application Scale	Software/Hardware
Online reference system for pharmaceutical evaluations	Major telecommunications vendor	Tens of thousands of screens, continuously expanding as new drugs are evaluated	Specially developed proprietary Tandem Computer software
User documentation for accounts payable software system	One of the two largest software vendors for IBM mainframe systems	Several thousand screens	Guide 3.0 Mainframes, Servers, and PCs
All field and credit procedures for retail stores	One of the largest national retail store chains	Eight million pages a year; analysis of current system to develop screens	Preference Mainframes, Servers, and Networks
Transfer of all procedural documentation—that used in-house as well as that supplied to customers—to an online system	One of the largest national mutual fund backend processing companies	12,000 pages of documentation	Preference Mainframes, Servers, and Networks
Instant online reference for account representatives for better customer service phone answering system	One of the largest national stock transfer companies	10,000 possible questions and their answers	Preference Mainframes, Servers, and Networks
Online marketing and sales information system	Mid-sized computer company	Several thousand screens of information	HyperCard Apple Macintosh

How Easy Is Routine Updating and Maintenance?

Introduction
In organizations, documents seem to have lives of their own. Some documents start out as fairly modest booklets and grow to amazingly large books. Procedures and policies are continually changing, but a basic series of documents may continue to live on the shelves year after year.

Updating
This means that documents have to be updated. New additions, deletions, and replacements need to be added all the time.
For some documents, only a few pages may be changed once a year. But for others, as much as 25% or more change can be expected annually.

People Don't Update Paper Manuals
The maintenance problem is compounded by the fact that the updating task is often relegated to the bottom of the priority list. And the fact is that the Murphy's Law of Manuals holds: If it isn't already out of date, it will become out of date the moment before you look something up in it.

MURPHY'S LAW OF MANUALS

IF IT ISN'T ALREADY OUT OF DATE, IT WILL BECOME OUT OF DATE THE MOMENT BEFORE YOU LOOK SOMETHING UP IN IT.

Plug-in Updating
The goal is to replace a single chunk of information in a large text without having to make extremely large changes in other parts of the text. The fact that Information Mapping's method divides the subject into precisely defined, clearly chunked information blocks makes the difference.

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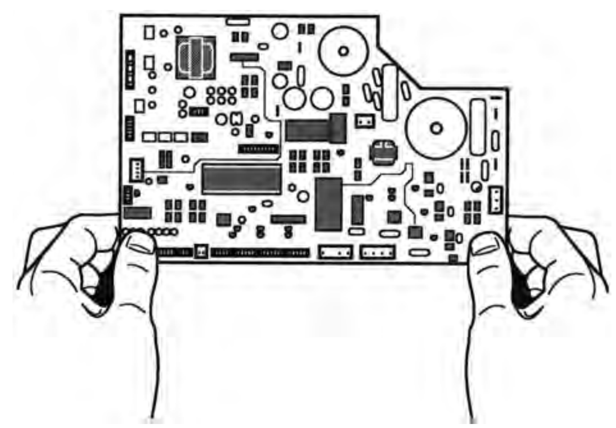


In designing equipment for maintainability, engineers have begun to develop plug-in components. So, if a defective part is found, it may simply be unplugged and replaced with a new one without having to do costly on-the-spot repairs. The information block operates in an analogous fashion in documents prepared with Information Mapping's method.

Aircraft Engineering Metaphor
The comparable situation here is the routine maintenance of aircraft. New parts are continuously being put into aircraft, while old parts are replaced. When a better subassembly has been designed, aircraft are routinely retrofitted. Over the course of 20 years, a considerable portion of an aircraft is replaced. The engines are overhauled several times and finally new ones are installed. When improvements in communications or better guidance radar are upgraded, whole parts of the aircraft may need to be replaced. Similarly, seats and other parts of the interior of the aircraft are routinely replaced during remodeling.

Another

Changing the Tire While the Vehicle Is in

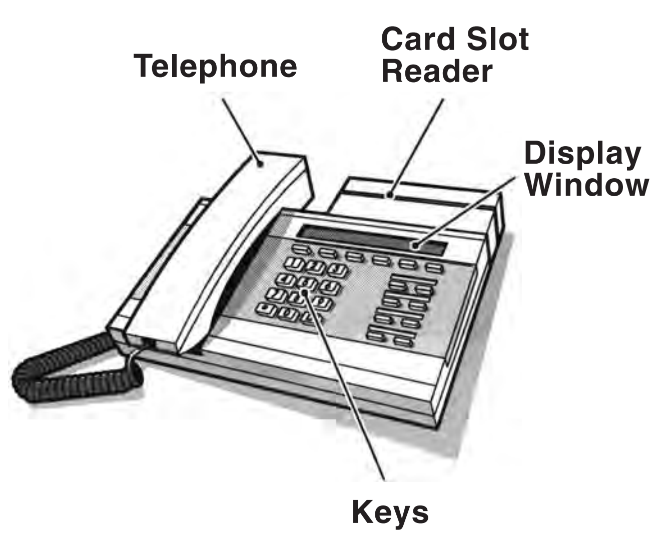
We are often called upon to develop documentation while the software is still being written and tested. Of course, that is better than writing it at the end of the project (which always misses its deadlines). In fact, the joke in Silicon Valley is that the first 80% of the software job takes 90% of the time and then the last 20% of the job takes another 90% of the time. One of our analysts once described the continuous changes that occur in software design while we are writing the documentation as "changing the tire while the vehicle is in motion."

Does It Work in Special Training Situations?

Introduction
In today's competitive business environment, marketing can use all the help it can get. This section explains how Information Mapping used its analysis and presentation methodology to solve a unique marketing problem for Wells Fargo Bank.

Training Systems Help Sales and Customer Service
Helping clients to understand and use new banking services can often make the difference in the sale of the services. Wells Fargo Bank in San Francisco faced this challenge when it introduced WellService, a new credit-checking service several years ago. Banks are accustomed to training their own employees but are less familiar with training their clients-a practice more common in other industries. The problem was to train retail clerks in how to do a large number of credit checks each day quickly and easily.

The Credit-Checking Service
The credit checking service involved the now common act of inserting the customer's credit card into a special terminal connected to a phone line. The information was transmitted to a central Wells Fargo computer which ran a credit check and reported back to the clerk in the retail store. It was a rather simple, straightforward operation. The problem was training clerks to do it quickly and accurately.



The Scenario: Busy Retail Setting for Operation
Imagine being behind the counter of a busy retail operation. People are waiting in line, asking questions, wanting to be served.

Low Level of Education and Little English Spoken by Clerks
The clerk to be trained typically had a sixth-grade education. Half of the clerks in the training population spoke English as a second language. Moreover, the turnover of retail clerks was very high. It would be prohibitively expensive to send a professional trainer out to show the clerks how to operate the credit checking terminal. Training had to be done by the store manager or, if the store manager was too busy, the training had to be self-paced. Relatively unskilled people, not reading English very well and working under pressure, had to enter the data correctly the first time for the system to work. With the added complexity of the rapid turnover of retail clerks, you have a significant data entry problem.

The Task
The credit-checking service itself was to be done on the GTE credit card–checking terminal shown in the drawing. When a customer presented his or her credit card, the clerk would slide the card through the slot in the top of the telephone and perform one of the procedures. Which kind of card? Was the customer using a California driver's license? Was it an out-of-state driver's license number? Did the customer want to cash a personal check? A company check? These and other variables had to be processed by the clerk.

The pricing and profitability of the service required that store managers be trained in the installation of the credit phones. They were also required to perform certain start-up, preventive maintenance, and diagnostic tasks which also had to be done in a self-instructional mode. It meant the reference materials had to work, or Wells Fargo would have had irritated customers all over California. Ruth Gilbert, the project manager for Wells Fargo, selected Information Mapping, Inc., to analyze the job and come up with a training package that would solve the various problems and help potential customers overcome their reluctance to buy the service. This would give the bank an extra edge over its competitors in the fierce struggle for banking business in the California marketplace.

Function as Both Training and Job Aid
After analyzing the situation, Information Mapping began to draw the outlines of the project. Because many of the clerks did not speak English well, the manual had to contain as few words as possible and rely more heavily on pictures and other graphics. The manual had to be quickly opened to the specific procedure and the clerk had to be able to do the whole checking procedure from that single page. Thus, the material had to function as both a training device and a job aid that enabled the clerks to retrieve just what they needed for the task- nothing more, nothing less. It had to handle all of the exceptions and error messages. Above all, it had to be simple to use and to learn from. It also needed to incorporate a section on installation and maintenance for store managers.

Task Analysis
Applying the principles of the Information Mapping method and training technology, analysts from Information Mapping, Inc., prepared a complete task and content analysis of the entire document. They worked closely with subject matter experts at Wells Fargo, and conducted numerous tests with the equipment under simulated field conditions. The task analysis provided a precise description of what the clerk or manager had to do in every conceivable situation. The content analysis provided a similar description of what the clerks or managers had to know in order to do the tasks.

Eliminate Most of the Words
After conducting a content check for accuracy and completeness, the team focused attention on content analysis and refinement of the task in order to eliminate most of the words and replace them with drawings and other graphics.

If your terminal shows...	Then...
RE-ENTER CARD	turn to Re-enter Cards
DECLINED	have customer call the bank where card was issued.
CARD EXPIRED	do not accept. Card is not valid.
LINE BUSY	turn to Using the Telephone
AMT. ERR.	check amount and decimal and re-enter amount.
PLEASE RE-ENTER	Press CLEAR start entry again.

The illustration shows how a more complicated decision was handled by the design.

Design of Manual
The manual was printed in three colors. Red-the actual color of the characters on the terminal screen-was used in the manual for consistency. The manual was designed to be rugged. It had to survive intact from year to year on a wide variety of retail counters. It was printed on very heavy sheets of laminated card stock so that it would not tear, especially along the edge where it was held by the three-ring binder. The binder itself was custom-designed to fit alongside the terminal in the open position for easy access. It could also be closed and shelved like any other reference binder.

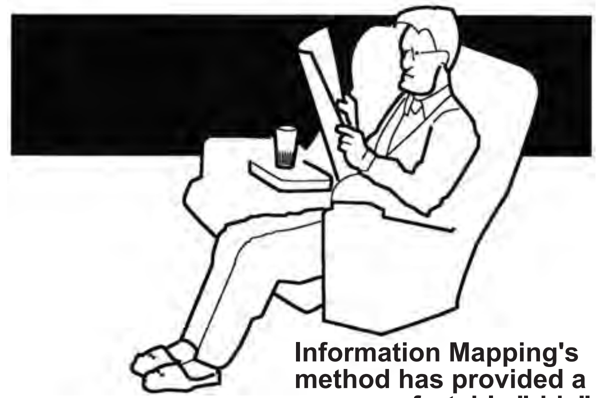
In-house and Field Tests
To make absolutely certain that the manual would work, it was tested in two ways. Simulated in-house tests with naive subjects were performed at Information Mapping and at Wells Fargo. This was followed by a full-scale field test with actual clerks and managers.
Results of Tests Ruth Gilbert told Information Mapping, Inc., "The manual worked perfectly from the beginning. It was an excellent combination of reference and training. The design was distinctive enough that it added to the marketing effort and made the service easier. There were very few questions phoned in by the clerks and managers who use the service all over California." The result was greater sales and better service.

Besides All That Efficiency and Effectiveness, Can You Provide an Attractive and Comfortable Journey?

Introduction
Information Mapping's consultants have developed a lot of documents that don't have to win prizes at an art show. Desk procedures are often of this kind. They just have to do their job of communicating information clearly. But in other cases, the situation requires that the document be attractive enough to make the reader as comfortable as possible.

Aircraft Metaphor

The comparable situation here is the attractiveness of the aircraft inside and out. How comfortable do the passengers find the seats? Is the lighting right? Is the paint job inside and out attractive?

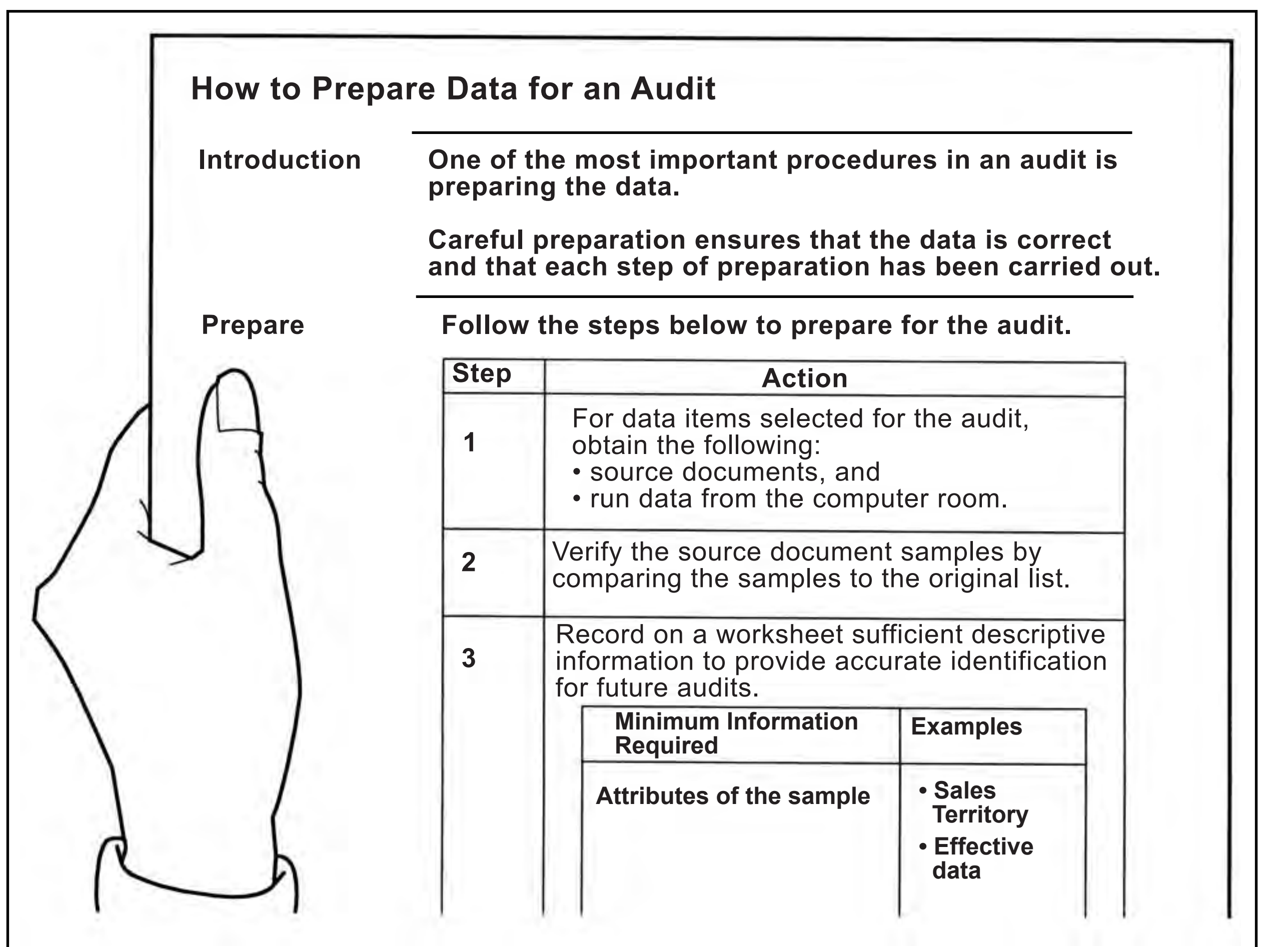


Information Mapping's method has provided a very comfortable "ride" for many years.

Example: Marketing Communications
Information Mapping's method has been used repeatedly in the preparation of marketing communications, especially when complex products or services are involved. Here the customer of our client is going to use the document. For such marketing and sales situations, it must be as attractive as possible.

We present three different presentation situations.

Example One: The Clear, Easy-to-Read, Easy-to-Scan Business Look
Here is a standard, everyday business form written in the Information Mapping method.



How to Prepare Data for an Audit

Introduction	**One of the most important procedures in an audit is preparing the data.** **Careful preparation ensures that the data is correct and that each step of preparation has been carried out.**
Prepare	**Follow the steps below to prepare for the audit.**

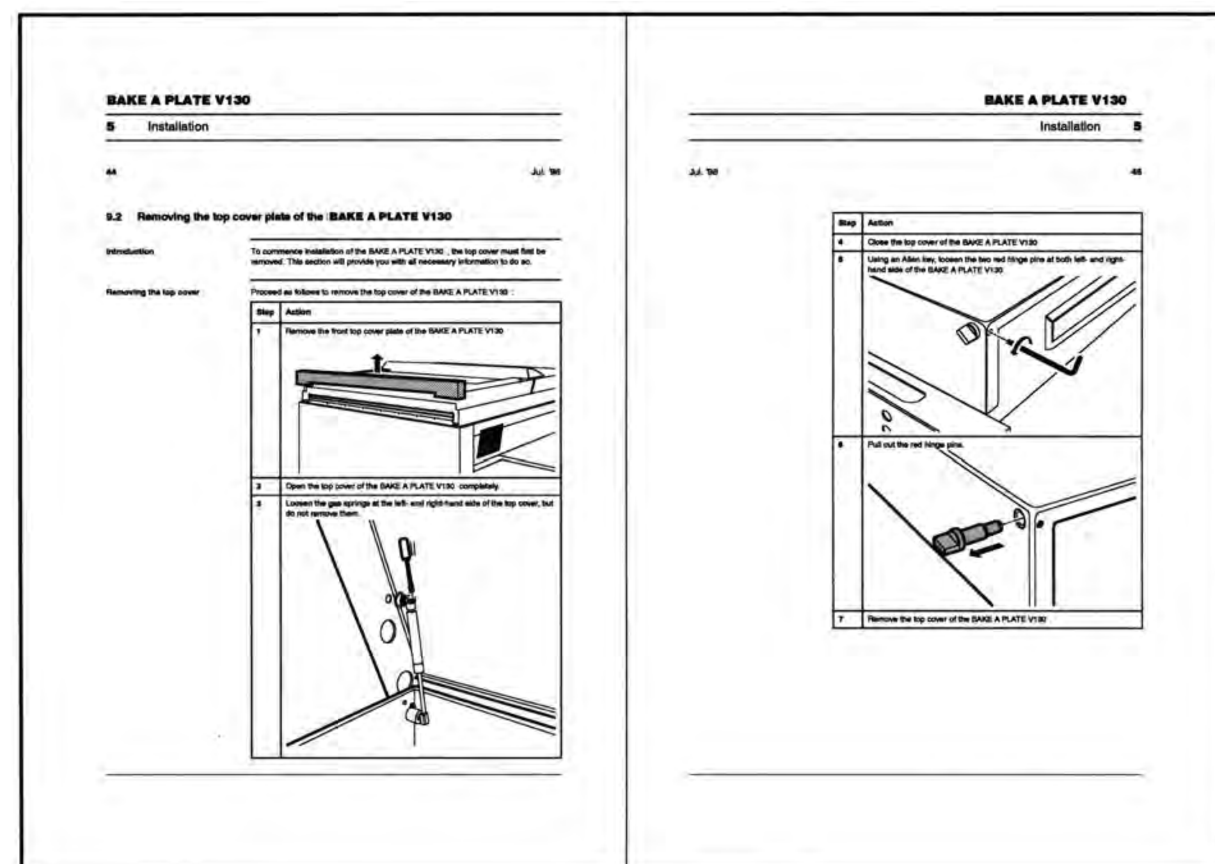
Step	Action
1	For data items selected for the audit, obtain the following: • source documents, and • run data from the computer room.
2	Verify the source document samples by comparing the samples to the original list.
3	Record on a worksheet sufficient descriptive information to provide accurate identification for future audits.

Minimum Information Required	Examples
Attributes of the sample	• Sales Territory • Effective data

Example Two: A Readable Screen in Highly Constrained Display Conditions
It is not easy to produce readable material on some screens. We often find the screen too small and the type choice limited. But the precision chunking provided by information blocks enables the information to be displayed with maximum ease of reading.

```
XYZ Company Administrative Systems   Screen 9.0  7/1/85

          SAFEGUARDING PROPRIETARY INFORMATION

OVERVIEW:
   INTRODUCTION: This section covers policies and practices
   governing proprietary information and restrictive markings.
   While this section sets forth guidelines for handling
   proprietary information, it cannot cover all circumstances.
   There is no substitute for using good judgment on the part of
   every Company employee.

   EMPLOYEE'S RESPONSIBILITIES: XYZ Company employees are obliged
   to protect proprietary information as a condition of employment.
   This responsibility extends to proprietary information received
   from others in the course of work activities

PLEASE ENTER YOUR SELECTION:

   __Next screen          __Related topics menu
   __Previous screen      __Main menu
```

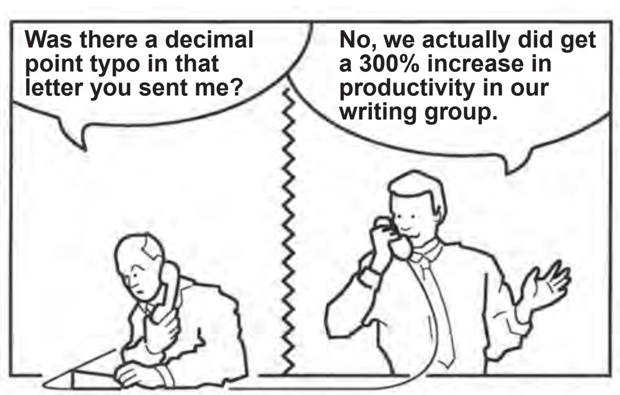
Example Three: The Fully Graphic Look
The method can be given full visual treatment, as shown in the example below.



Does It Increase Productivity?

User Reports a 300% Productivity Increase
In one of the earliest seminars that I conducted, there was a young parts and procedures manager named Bob Labossier who was working for the makers of Nissan automobiles in the United States. He sent his entire staff to one of our seminars. After his staff had learned Information Mapping's method, he wrote me a letter in which he said that he had increased the productivity of his procedure writers by 300 percent.

I Suspect Error
I read the letter three times. I couldn't believe what I had read. I knew that Information Mapping's method would improve writer productivity, but I had no idea that it might improve it that much. As I thought about it more and more, I suspected that his secretary had put an extra zero in the letter when typing. Around 30 percent would certainly be a more realizable and realistic goal for most organizations.



Double-Check Reveals no Error
So I decided to call Bob and ask him to verify the figure. He said "No, there was no mistake."

He said he had kept very careful records of the output of his writers over the past years and had tracked them for six months after they learned structured writing in the seminar. The productivity increase was definitely 300%.

Explanation of Productivity Increase
I asked Labossier how such a high productivity increase could happen.

Faster and Better Analysis. "Well, the savings come from all over. Part of the increase came from better analysis. You don't have to redo a good analysis. We frequently had to start all over from the beginning because somebody started the analysis from the wrong perspective in the past."

Faster Writing. "Part of the increase also comes from faster writing. My writers get the first draft done faster, because they know precisely what they're supposed to do. And they know when to stop! They don't write endless details-only the relevant ones."

Faster Review. "Finally, another part comes from faster review time. Less time waiting for upper-level managers and technical experts to approve. Not that they're sitting around, but any delay in approval and review tends to slow down the whole process."

Half the Job of the Procedure Writer Is Answering the Phone
Here's another story. It goes under the category of "watch for things that don't happen," or in evaluation, "pay attention when nothing happens!"

In one large organization that had almost 1,000 writers we found that one of the major job responsibilities of a procedure writer was to answer the phone for questions from the field.

The questions occurred because material they'd written was ambiguous and the people in the field could not understand parts of it. No exaggeration here-managers fully expected 50% of a writer's time to be used in answering the phone for questions from the field.

One supervisor was assigned to write procedures related to labor relations. As soon as a labor contract was signed, she had 30 days to get new procedures out into the field and into the hands of first-line supervisors. Just after she took Information Mapping's course, a labor contract was signed and she wrote a group of new procedures with her new skills.

Nothing Happened
As usual, the woman who wrote the procedures set aside the following week to answer the phone. Much to her surprise, however, the phone did not ring. Accustomed to handling many foul-ups, she began to get worried-perhaps the procedures got lost.

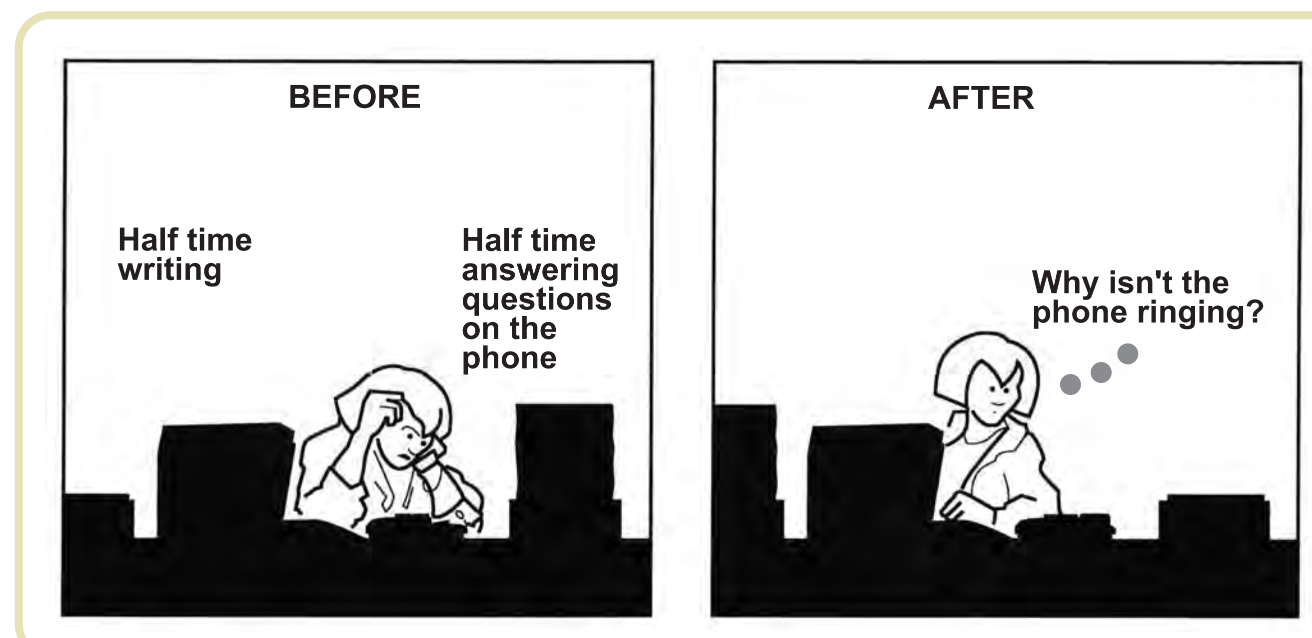
At that point, she started the sensible troubleshooting procedure.
□She tracked down the print shop and asked them if they had printed the procedures. Yes, they had printed them. She called the mailroom supervisor to ask if the procedures had been sent out. Yes, they had been sent out.

She couldn't blame the lack of phone questions on the mail- room. The U.S. Postal Service must have lost them.

To check if the procedures had arrived at their intended destinations, she called a supervisor in the southern part of the state.

Yes, the procedures had arrived. Yes, he had given them to his workers.

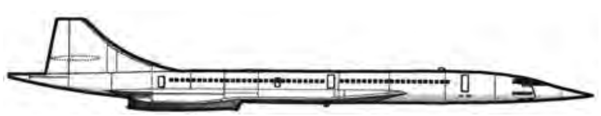
No, there were no questions. "Why should there be questions? They were very clear," he said. Now she does not schedule half her time to answer questions. She has, in effect, doubled her efficiency.□□□



Is It Cost-Effective for Its Mission?

Introduction
In business, a critical question about any product or service is: "Is it cost-effective for its mission?"

Just because an aircraft can be built, and even though people like to fly in it, it doesn't automatically follow that it will be cost-effective. The British and the French, for example, found that the Concorde, which flies at supersonic speeds, could not be operated profitably, even on the most heavily-traveled trans-Atlantic air routes.



The Cost-Benefits Questions
Similarly, in the fields of training, documentation, and writing, the cost-benefits question is paramount. For these endeavors, getting the cost and benefits information together requires the analysis of your information inputs and outputs. Thus, the major question must be asked: What are the costs and benefits of specific applications?

In order to answer this question, you must consider that the costs and benefits are quite different depending on your point of view, i.e., whether you are looking at the benefits from the standpoint of:
- the reader or user of information,
- the writer, or
- the organization.

We will now examine these three cost-benefit perspectives.

1. Costs and Benefits for the Individual Writer or Analyst
The Writer's Perspective
The question from the standpoint of the individual analyst or writer is, "How much time/stress could I save after becoming proficient in Information Mapping's method?"

When you are examining this question from the standpoint of your own job, certain numbers will be significant. According to one widely quoted study, managers will spend 10 to 20% of their time analyzing and writing. Technical people may spend up to 90% of their time in these activities.

Benefits
Benefits include:
- More time available to solve major job-related problems and less time writing
- Better analysis of problems
- More productive meetings (because of better preparation)
- Less time answering questions from recipients of your communications (because you have been clear and complete)
- Personal energy savings (which may be greater than hours saved, because analysis and writing are often experienced as the most difficult and most tiring activities of the day).

Cost Factors: Here are some of the factors to consider
When calculating costs, consider these factors:
- training time and tuition
- time away from the job.

Typical payback periods average one year.

If you use three-year payback as a criterion for a worthwhile in- vestment return, the personal and organizational rewards are well worth the

2. Costs and Benefits for the User or Reader
The Reader's Perspective
The question from the standpoint of the individual reader is:
"How much more efficient and effective could I become if everybody in my organization delivered documentation and reports to me using Information Mapping's method?"

If you are on the receiving end of information, you have a different costs and benefits perspective. Recent surveys have suggested that 50 to 70% of the written communications that managers receive are written by people who report to them. This means that managers can control 50 to 70% of the quality of what comes to them. And other observers have calculated that an average manager may well read or skim a million words a week.

Benefits
Much of the benefits come from time saved in search and retrieval and less training time. We saw earlier that Pacific Bell saved 50% training time in one course. But benefits also have been identified in terms of more attention focused on real problems and better analysis done by readers based on better information provided.

Cost
To figure costs, the manager can estimate the amount of time spent reading during the week. Reading time can easily reach 2 hours per day if evenings and weekends are included. This time spent includes going through the in-box daily, looking up policies, procedures and guidelines, reviewing training materials and instructions, and reviewing drafts of subordinate and peer-written material. The use of Information Mapping's methods by all of the people in an organization can save up to 50% in reading and review time.

To save training and documentation costs internally, some organizations have insisted that their suppliers use Information Mapping's approach for product documentation. Consider what the savings to a large engineering organization would be if all documentation from their vendors met the quality control standards described in this chapter.

3. Costs and Benefits for an Organization or Project
The Organizational Perspective
The question from the standpoint of the organization is: "What are the costs and benefits of specific projects or operations if they are done using Information Mappings's method?"

Benefits
The benefits obtained by a whole organization depend on the type of company. Every cost-benefits study will be unique. For example, the benefits to a package software company will be calculated in terms of:
- increased sales,
- increased customer satisfaction,
- lower costs in customer service, and
- lower overall documentation costs.

The benefits realized by companies that write their own documentation in their Management Information Systems departments are quite different. Some of these benefits would be:
- higher-quality system use;
- increased productivity of writers, analysts, technical, administrative, and managerial personnel;
- reduction in time spent by subject matter experts;
- fewer errors;
- reduction in time spent by supervisors answering questions;
- reduced training time; and
- reduced hotline costs.

To calculate benefits, each department, company, and industry would have a different profile.

Costs
Typically, the major costs would be in training people to write using the method.

Aircraft Engineering Analogy
Are the parts and subassemblies selected for an aircraft? How do they know the parts will work? What are their properties?
The documentation engineering equivalent of these questions can be translated as:
- What are the principles and criteria you used to select and build the parts?
- What is the research on the various parts of the system?
- What are their operating characteristics?

Introduction
When engineers design an aircraft, they use the best components. They make sure that each of the components has been tested and evaluated by its manufacturer. They test the quality control and assembly line methods used in putting together the aircraft out of the components.

Research on the components of Information Mapping's method has taken place in a variety of fields over the past 50 years. We have relied on work from:
- cognitive psychology;
- learning and education;
- human factors engineering;
- communications;
- advertising;
- graphics, design, and typography;
- linguistics; and
- artificial intelligence.

Engineering Analogy
If we think of Information Mapping's method as a kind of documentation engineering, we realize that only recently has the field emerged as a field by itself. It does not have a separate research community distinct from the fields mentioned above. One may think of its reliance on other disciplines as similar to engineering's reliance on research in the basic sciences.

Much Research Done In Many Disciplines.
It goes far beyond the scope of this chapter to summarize all of the research we have relied upon to design and build the components of the Information Mapping method. But basically, in the chart on the facing page, we divide the studies by their range of applicability.

For instance, there is basic psychological research on the capacity of human short-term memory. It concludes that human beings have two different kinds of memory: short- term and long-term. Further, that we have very limited capacity for holding information in our short-term memories-somewhere between 3 and 9 chunks. Just as the aircraft engineer is always working against gravity, the documentation engineer or writer is always working against the limitations of human memory.

Experiments on Specific Elements of the Method

This level of experiments includes work on specific elements of the display aspects of the method. I have summarized a number of these in Mapping Hypertext, Chapter 8, including classic papers by Hartley and Trueman (1983) on the effects of headings on retrieval, and Reid and Wright (1973) on visual structuring of information. Reid and Wright's study comparing the usefulness of particular kinds of graphic constructions (tables, trees, lists) with prose paragraphs is applicable only to certain subassemblies in certain kinds of documents. Some psychological and linguistic research (e.g., a whole series of papers by P. C. Wason) has focused on identifying the types of grammatical constructions that are likely to produce errors in human information processing. This research is applicable only to the construction of certain sentences. It is important to note that these are not studies on Information Mapping's method, but on elements which are used in it.

Experiments on Basic Human Capabilities and Characteristics

These experiments include such basic studies as how human short-term memory works and what its properties are. We have summarized a number of these in Mapping Hypertext, Chapter 8, including classic papers by G. A. Miller (1956) and Herbert Simon (1979). Studies on how human beings learn concepts would, for example, be utilized at this level of synthesis of a methodology.

Experiments and Evaluations of the Whole Methodology

Many of the studies described in the following chapter compare the outcomes of learning or preparing reference material according to the method with material prepared in other fashions

Can You Measure Critical Variables in Its Components?

Introduction
Precise measurement has improved efficiency in science, technology, and business.

Let us think about measuring different variables that appear in text. Is knowing how many words are in a manuscript a meaningful measurement? Yes, to some degree. You can determine approximately how big a job it will be to read or store it all. But it tells you little about the contents. Suppose you counted all of the paragraphs. What would that tell you? Not too much, because a paragraph, as we all know from casual reading, can be anything from one sentence to a whole page. So a paragraph count might give you a rough idea of the size of the manuscript, but it is not as precise as a word count.

Counting Blocks
Documents developed according to the Information Mapping's standards of structured writing give us greater possibilities in content measurement. We can count blocks. Because each type of block is developed according to a specific set of criteria, they are comparable, and hence, countable. If we say that there are 29 definition blocks and 185 example blocks in a given book, we know something very precise. If we say that there are 1,726 blocks in the total document, we know something much more useful than a word count. A word count includes all of the relevant and irrelevant words in a document. We can even get word counts of sloppily-written documents. But a document written following the guidelines of Information Mapping's method enables us to know a great deal about the contents because we know the total block count and the count of different types of blocks.

Counting Task-Oriented Procedures
Procedures are also worth noting. We know how much task-related learning must take place from a structured document, because we know that the procedures and decisions have been developed according to specific guidelines. This means that we can count the number of individual procedures and also the number of steps in each procedure. So, it becomes very meaningful to say, for instance, that out of 1,726 blocks, 299 of them are procedure blocks and these procedure blocks contain an average of 8.2 steps per procedure.

If we have a document of 1,433 blocks and only 22 procedures averaging 4.3 steps, we can anticipate quite a different sort of learning (or writing) task.

Use in Planning Stage
This ability to be precise gives us a very powerful tool for various practical and research-related tasks.

On the practical side, suppose that we are asked to write a particular kind of document-say, a personnel manual. We can examine several examples of manuals that already have been written according to Information Mapping's method, and make a good estimate of the size and difficulty of the task facing us, even in the absence of the actual subject matter. Of course, when we can examine the documentation that can be used in the preparation of the new manual, we can estimate the difference between what we have and what needs to be done. This is of considerable value to the project manager and writers, no matter what level of formality is used in the examination. Because the documents have been chunked precisely into blocks, they provide an intuitive guide to the kind and number of blocks that one can expect to write in the project.

This provides guidance of invaluable assistance at a very critical stage of the project.

Evaluation and Quality Control
Measurement (i.e., counting of critical variables such as blocks) can aid in quality control and evaluation of a final product. One such case is the definition-example ratio: If the ratio of definition blocks to example blocks is high, the learn- ability of the material for naive learners may be smaller than if the ratio were lower. This means, for instance, that if you have 50 definition blocks and only 30 example blocks, the material will be harder to learn for a group with low ability or which lacks prerequisites than it would be if it had 50 definition blocks and 150 example blocks.

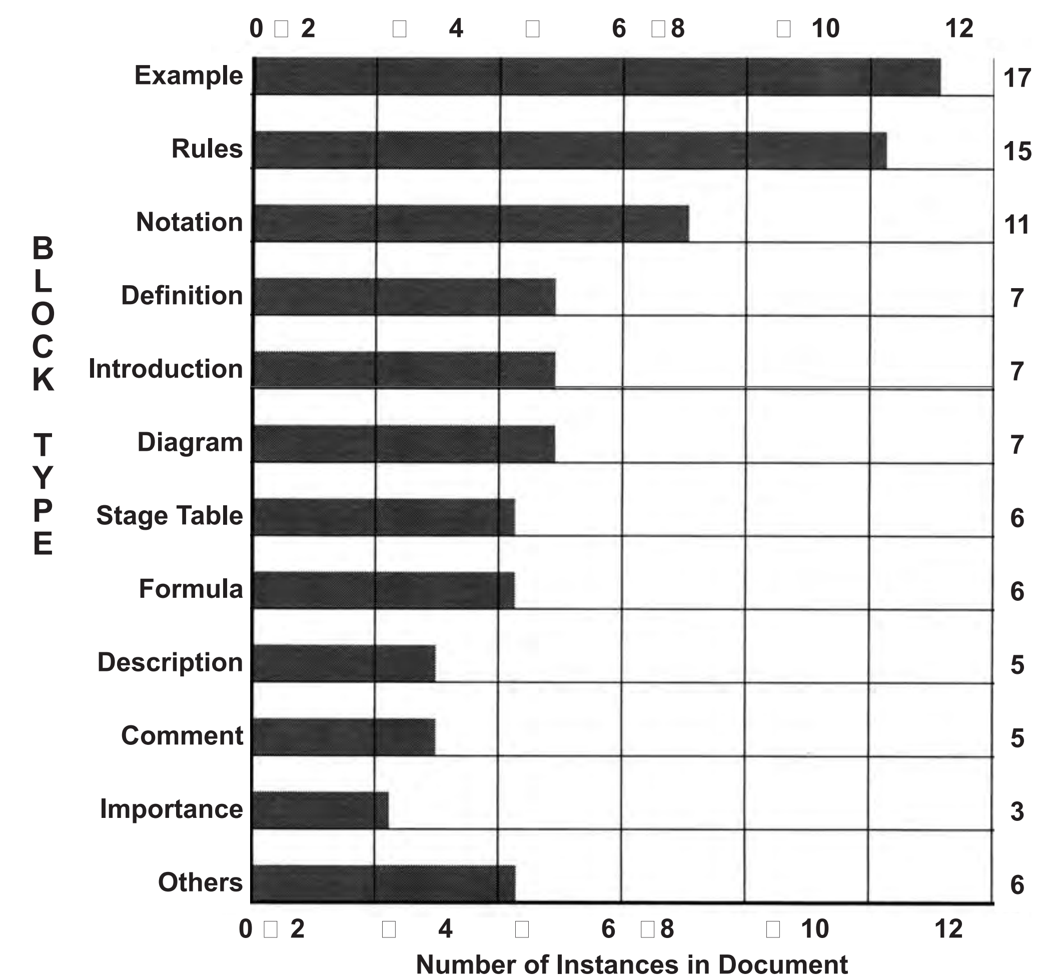
Research Applications of Block Counts
The ability to count blocks and other features of texts prepared according to Information Mapping's method gives a researcher a precise measurement of the difficulty and content of the subject matter.

When the researcher wants to examine all of the blocks of a given kind, they are countable, identifiable, and comparable, and they can be examined in their contexts.

Different Document Types Have Different Proportions of Block Types
One of the interesting results of investigations of this way of counting content is that similar manuals give similar profiles of block types. If you got together 100 procedure manuals or 100 policy manuals, you would see a great similarity of the kinds in information blocks appearing in them.

The Data
The document described in the chart below is one that was used in two of the experiments described in the next chapter (those of Soyster and Hauck). The chart illustrates how it is possible to describe the content in a meaningful way without specifying the actual terms used in the subject matter.

Number of Information Blocks in Principles of Hydraulics by T.G. Soyster



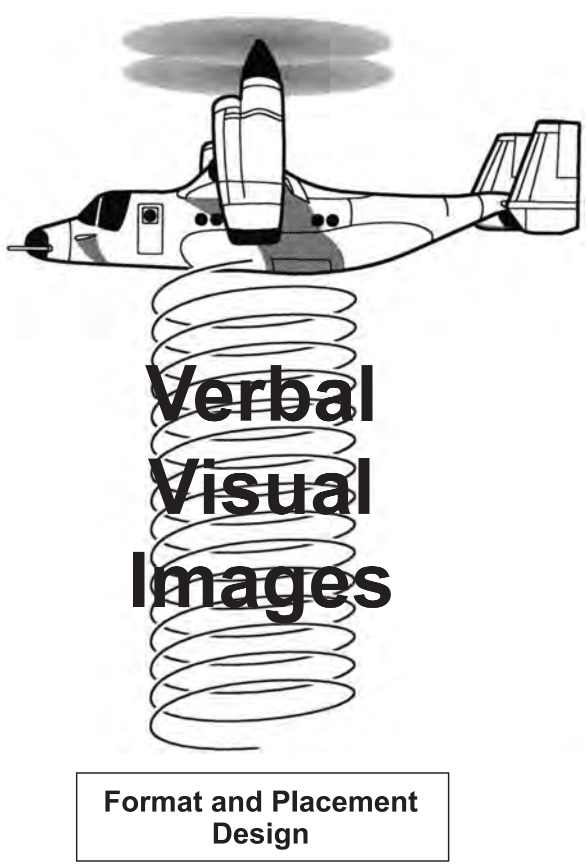
Note: The % of Total Column adds up to 95% due to rounding.

Can You Do Creative Things with It?

Introduction
We have described a considerable number of very precise ways of developing structured writing. Having seen the documentation engineering metaphor throughout this section, the reader may have formed the impression that writers are left very little with which they can be creative. This is far from the case.

Creativity Always Works within a Context
Whether we are examining writing, engineering or any other art or science, we see that creativity does not just magically happen. Creative works don't pop into existence. Creations make use of standard situations and materials. Creation assumes contexts.

You can expect similar outcomes with Information Mapping's method. Yes, there are a great many guidelines. Yes, the practitioners must have learned these guidelines and concepts before they can expect creative output. But that is not the whole story. Creativity abounds in some documents that follow the guidelines of the method.



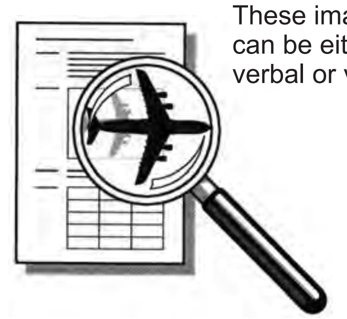
Opportunities for Creativity
Some aspects of a technology or art form present greater opportunities for creativity than others. What are some of the opportunity areas for creativity in Information Mapping's method? Here are some:

Examples. The creation of vivid, clear, interesting examples is perhaps the greatest continuing opportunity for creativity. Examples frequently represent the greatest amount of writing in a document, and the development of the "right" example can give the reader the concrete feeling of being there, seeing it, knowing it.

Metaphors and Analogies. Functional communication material used in business and technology can benefit greatly from apt metaphors or analogies. They can carry the reader along, like skiing down a slope, whereas inept metaphors can confuse the reader, like running into a grove of trees halfway down the mountain.

Verbal and Visual Imagery. Images are sometimes the spotlights of a paragraph or block. They brighten up and focus the reader's task.

Placement and overall design. Another opportunity for creativity within constraints is the use of different formats and graphic design layouts for presenting material. Obviously, this requires additional skill, and we have frequently recommended that clients use one of several standard formats for displaying the Information Mapping method rather than creating new ones. The major reason for this is that format is very important for enabling scanning and retrieval of information from a page. Tinkering with the type weight and style of headings and text can seriously contribute to or impede a user's ability to use the material effectively and efficiently. Therefore, we recommend the value of ease of use for the reader over the frequently emphasized values of novelty, style and expression.

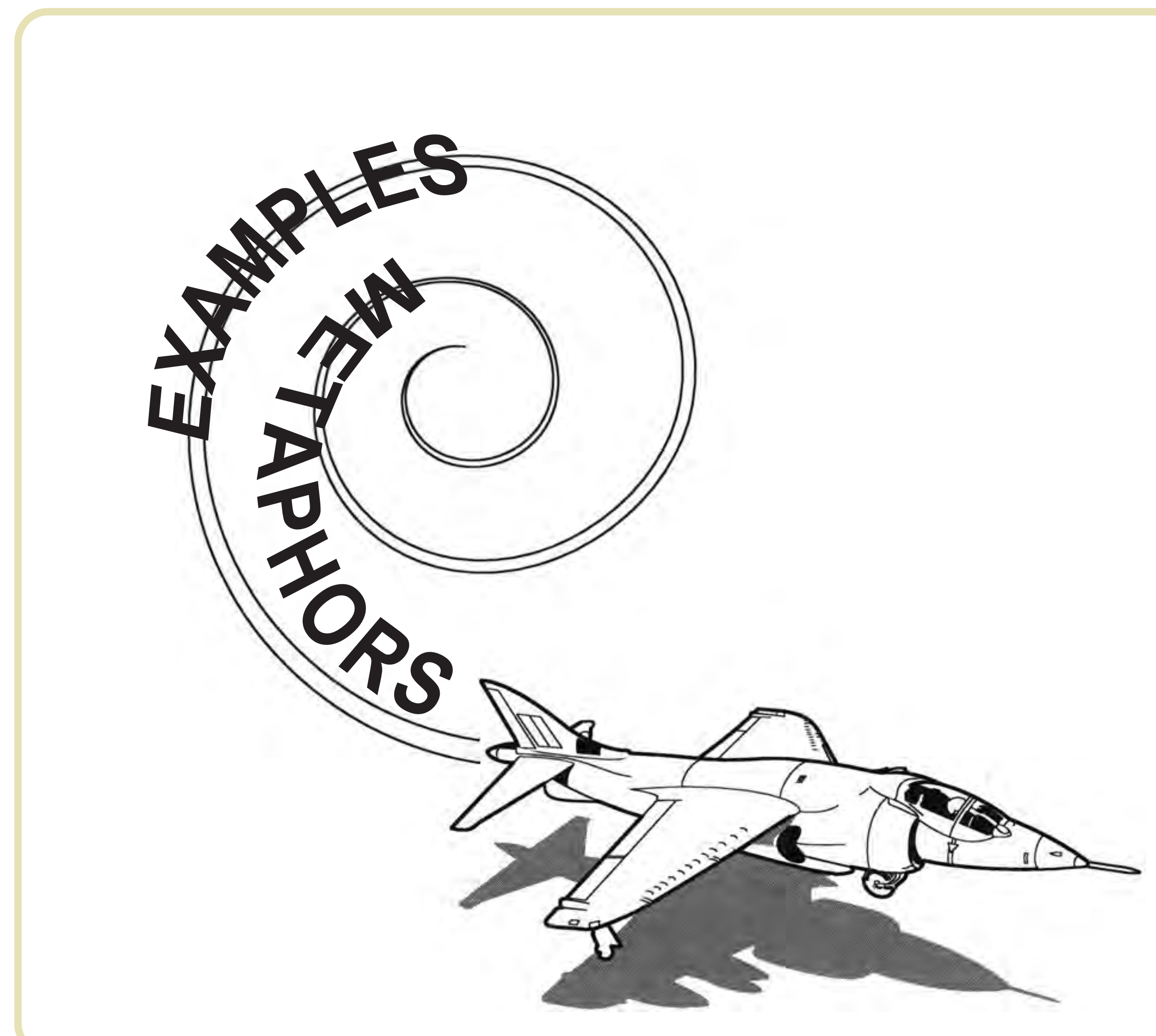


These images can be either verbal or visual.

Comment on the Aeronautical Metaphor
"Can the aircraft do loops and rolls? Can it land on a dime? Can it fly onto a little Pacific island that is perhaps the most beautiful place in the world but has a tiny landing strip? What color will the plane be painted?" These are not the first questions aircraft engineer address when they design and build aircraft. But these questions may be very important to particular groups of users.

Similarly, the questions of creativity in using Information Mapping's method arise after the writer has mastered the fundamentals of the craft.

Another Metaphor: Architects and Engineers
Perhaps one way to illuminate the relationship between creativity and the discipline of Information Mapping's method is to look at an architect's dependence on engineers. There are some fundamental engineering disciplines, such as structural engineering, that are supremely important in the designing of buildings. Similarly, I like to think of Information Mapping's method as a kind of structural engineering, and creative expression as the addition of certain kinds of form and detail to the overall structure.



Will It Aid in Discovery of Design Flaws in Other Parts of the Process?

Introduction

The topic we turn to next is not necessarily one that we would set up as a requirement of a communications methodology when initially developing it. But we have done a large number of projects in computer documentation. In each of them, the evidence began to accumulate that we had uncovered an unanticipated, yet extremely valuable aspect of Information Mapping's method.

The design of computer software has become one of the most complex design activities that humans undertake. Complex activities are the breeding ground for error. While there has been a great deal of progress in structuring the design process so that errors are reduced, commentators still estimate that there is one error in every hundred lines of code.

Some of the most pernicious errors are those that happen early in the design process. If the level of complexity is high, it is inevitable that software engineers will leave out important specifications. Moreover, there is always a tendency to overlook the interactions of different complex parts that may produce unanticipated difficulties for users.

Information Mapping's Role in Quality Control

Very often when our documentation project managers and information analysts begin working with software teams, they will ask a series of questions generated by the structured methodology of Information Mapping's method. Quite often these questions will result in the expert pausing and then saying: "Oh, my God, we didn't think of that! How did you think of it? You've only been learning about the system for a couple of days, and I've been working on it for a year!"

Why the Method Uncovers Errors and Design Flaws

We began to get interested in this design flaw discovery feature of Information Mapping's method after this happened several times. We believe there are two properties of the method that make it easier to discover errors when applied in software engineering projects.

Example and Non-Example Generation. One of the specifications for the technical analysis of concepts in Information Mapping's method is a requirement to generate sufficient examples to cover the range of attributes of a concept. This means that the definition of the concept is tested across all of its significant dimensions.

In software engineering, one typically generates data sets to test all of the dimensions of a given numerical routine. The generation of examples in Information Mapping's method is analogous to these test data sets.

Furthermore, Information Mapping's method has a specification for the generation of non-examples that will communicate to the user its limits or instances in which a concept or function does not apply. Non-examples also act like a data set test situation in which you generate a set of wrong data to see how the software calculates on it.

Recursive Question Generation. One of the important properties of Information Mapping's method is that it enables information analysts and writers to generate questions. These questions are triggered by empty blocks (i.e., information blocks that should be a part of a given map about a topic but for which the writer has no information). This typically triggers the writer to go to the subject matter expert-the software engineer-to obtain the answer. Because our theory suggests that different types of information should have very specific pieces of information associated with it for good communication, particular questions get asked. And these questions are very frequently more systematic than what the software engineer has used to figure out how a particular part of the software operates.

I want to be clear here that I believe that many of the errors that Information Mapping's analysts are able to catch are those which would have eventually been caught somewhere along the line, in alpha or beta tests. But these errors should not be permitted to get that far. As we know from studies of software engineering economics, the later the error is found, the more expensive it is to the development process.

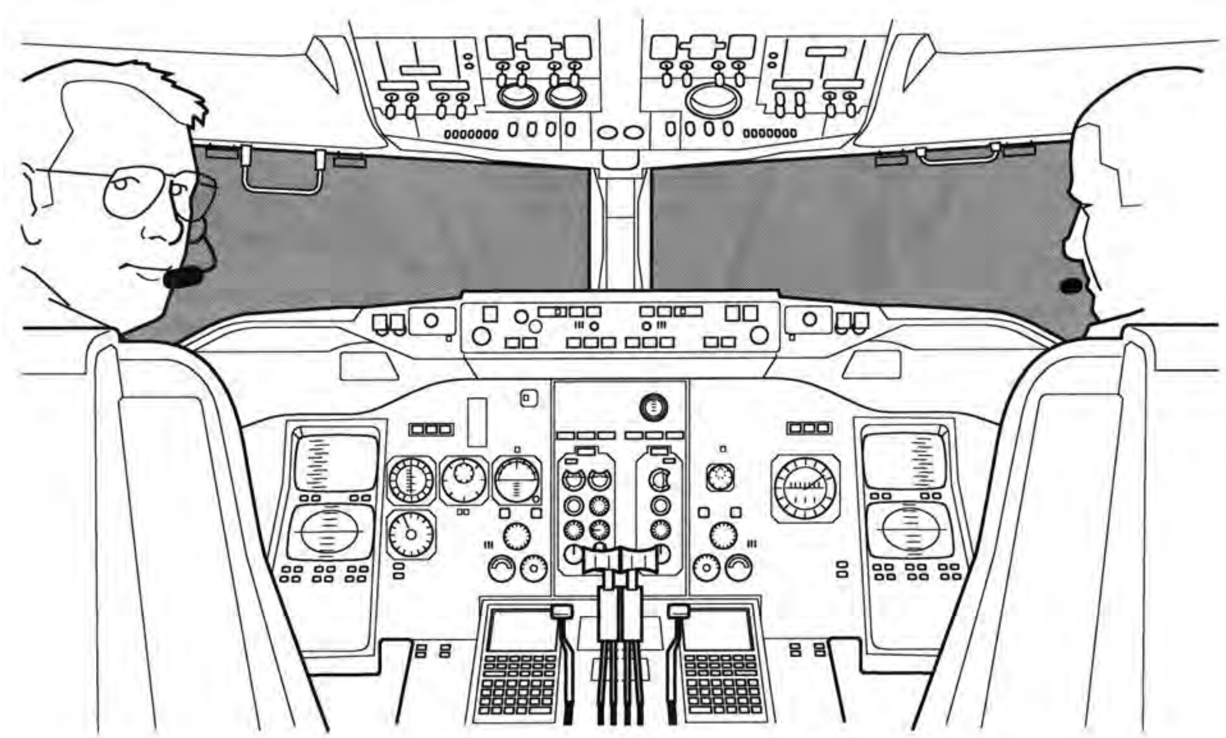
Suggested Solution: Develop User Manual First

One of the things we have frequently recommended to clients is that they prepare the user manual of the documentation first, at the time the product is being specified, rather than at the end of the project. The design flaws normally caught in our process of developing the manual are thus caught early enough to save a great deal of money.

Comment on the Aeronautical Analogy

Perhaps the "flaw discovery" property of Information Mapping's method described on these pages would be very much like the systematic planning software routines that engineers use to check their designs. Or perhaps it is a way of putting the aircraft in the wind tunnel to see how it will react. Both test the properties of the aircraft under different conditions.

Similarly, an analogy can be drawn to cockpit design tests where test pilots sit down in a simulator to determine if the dials and controls are usable, and to make suggestions on how something would be better from the pilot's point of view.



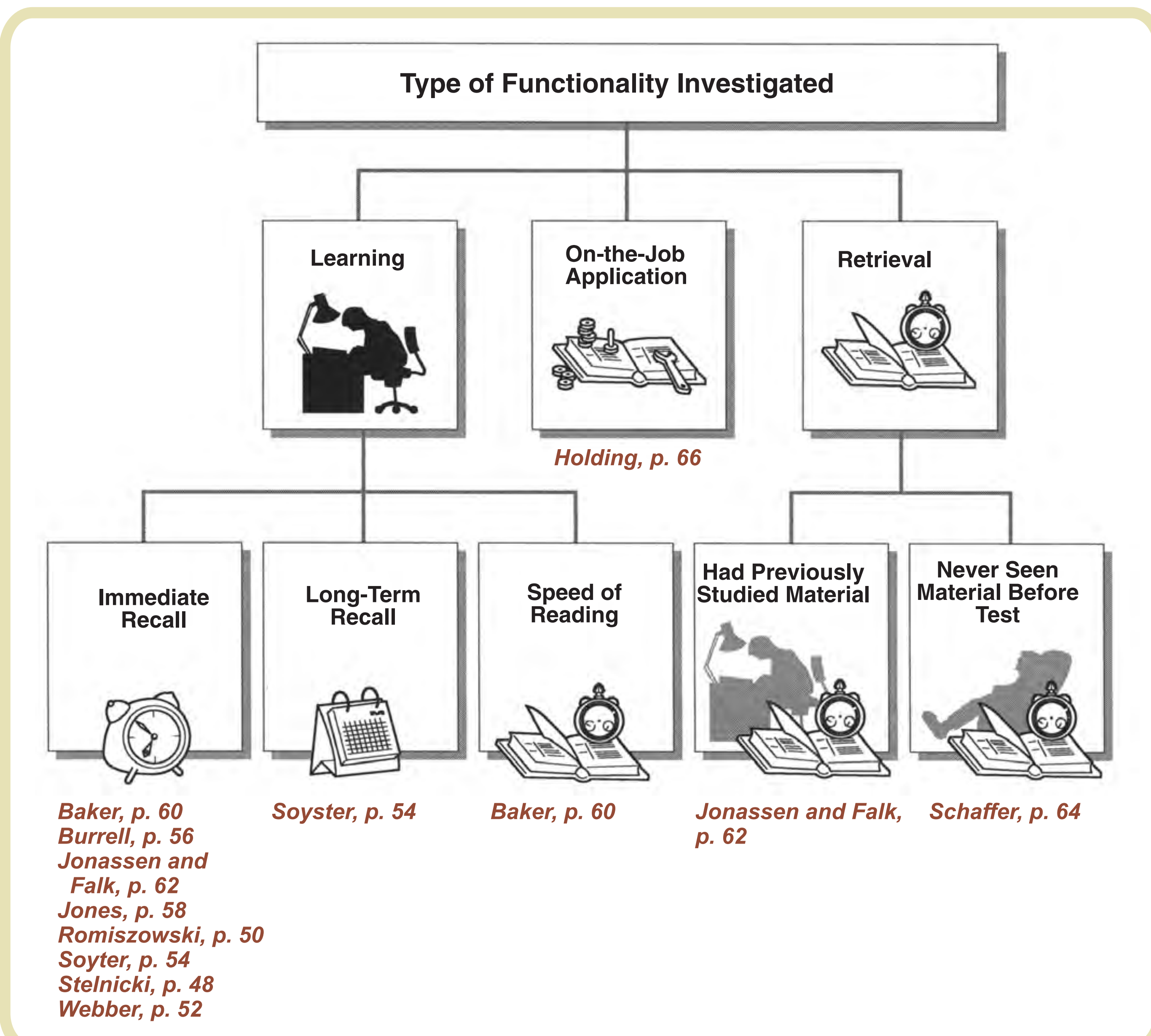
Overview of This Chapter: Abstracts of Research

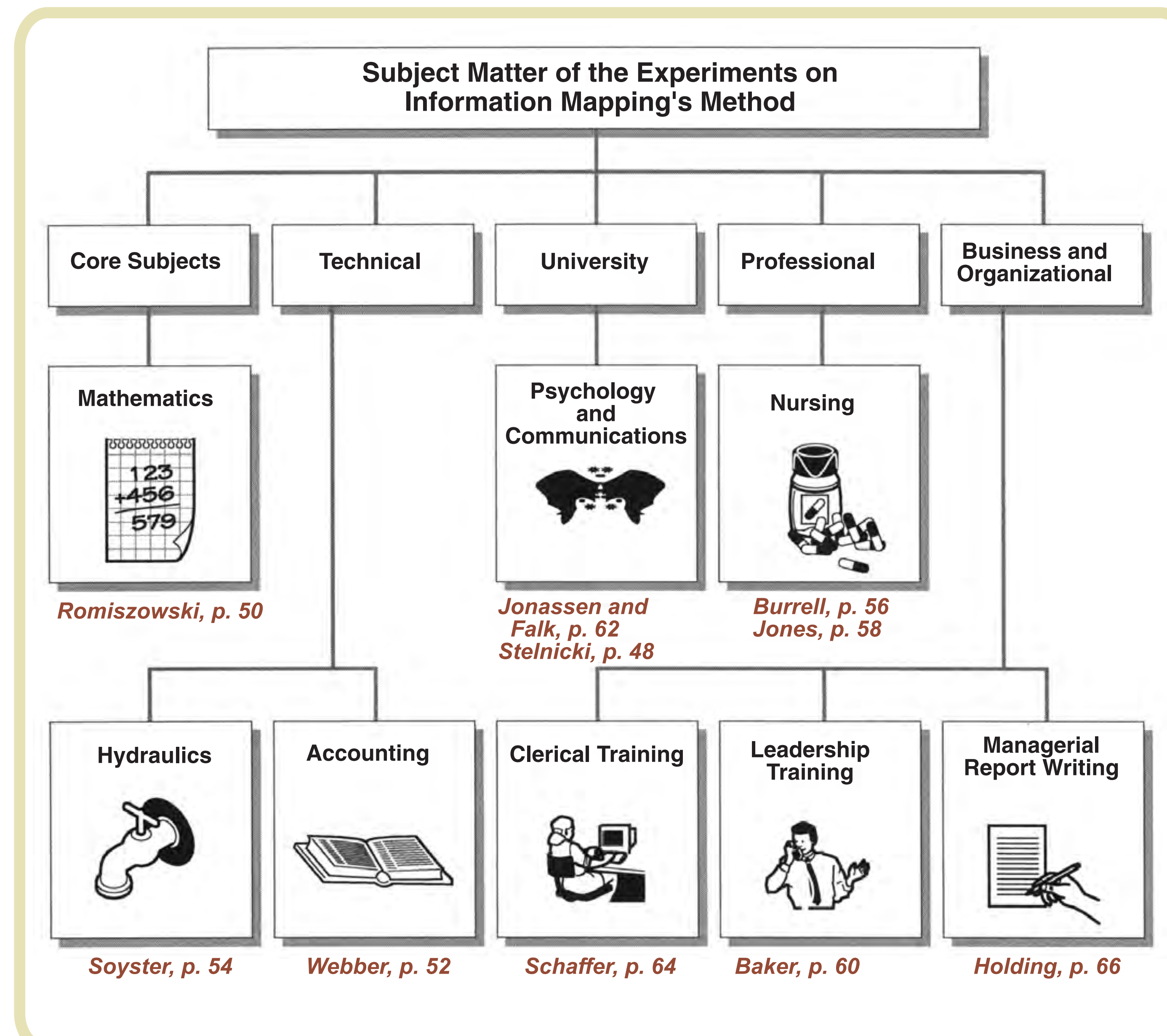
Introduction
We can evaluate training and retrieval methodologies in a variety of ways. We have surveyed these evaluation approaches in the previous chapter. In this chapter, we present more detailed abstracts of major research and evaluation studies conducted in universities and in business. These studies have covered a wide range of subjects, training and retrieval situations, and learners. The emphasis in this chapter is on presenting results of research done independently of Information Mapping, Inc., but focused on its methodology.

Charts on These Pages
The next 4 pages present tree-like classifications of the research reports. The research is listed by author and page number along the bottoms of the charts.

The charts on these 4 pages show the results of the same studies from different points of view. A study is mentioned 2 or more times if its results apply to 2 or more factors (e.g., Soyster measured both immediate recall and long term recall, so he is mentioned twice).

Questions Answered by the Charts
These charts sort the research according to the various questions the reader might have:
- What was the researcher trying to find out?
- What kinds and levels of subject matter documents were used in the research?
- In what organizational settings was the research done?
- What level of learners or users of the documents participated in the experiments?





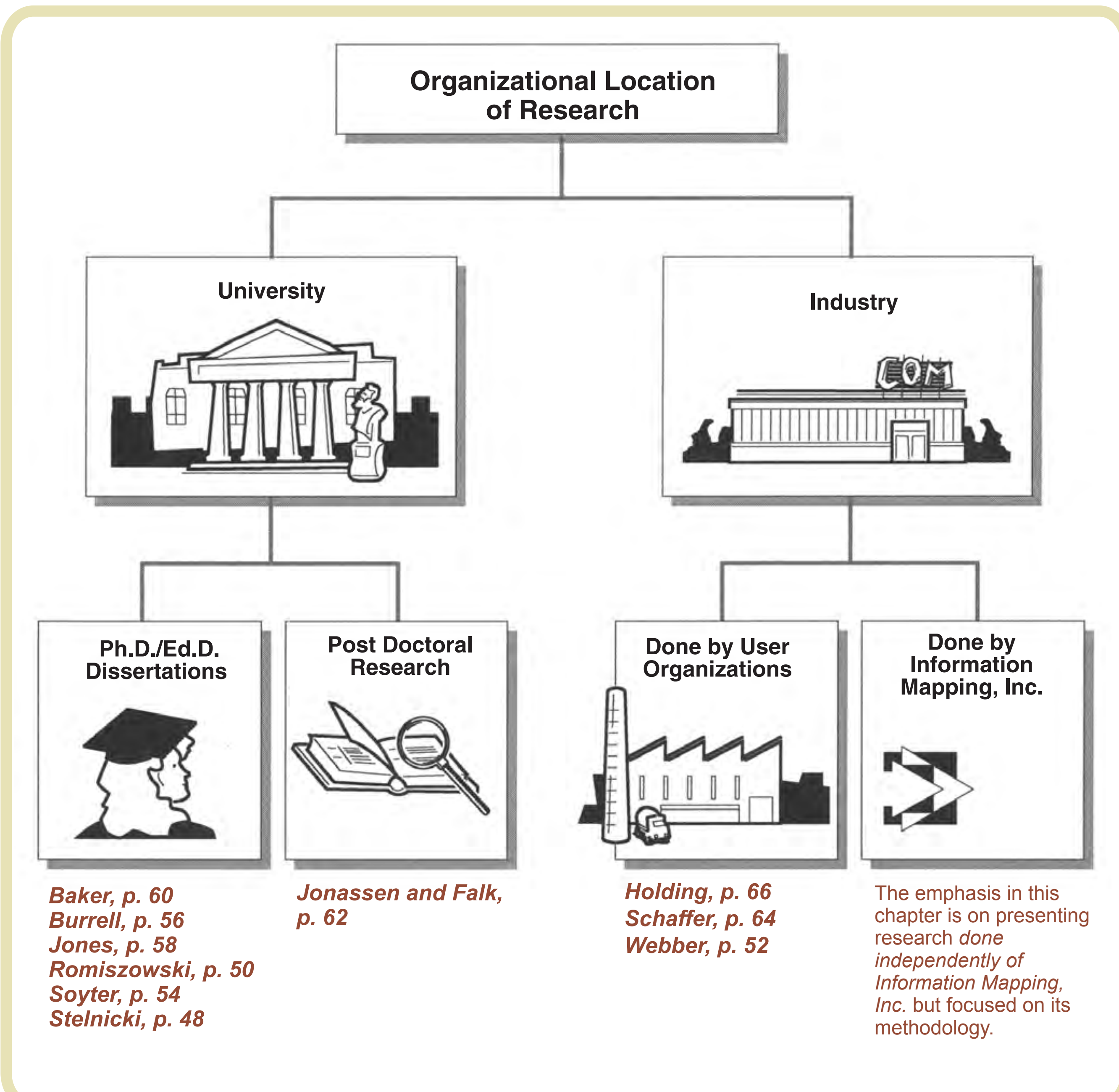
Overview of This Chapter, continued

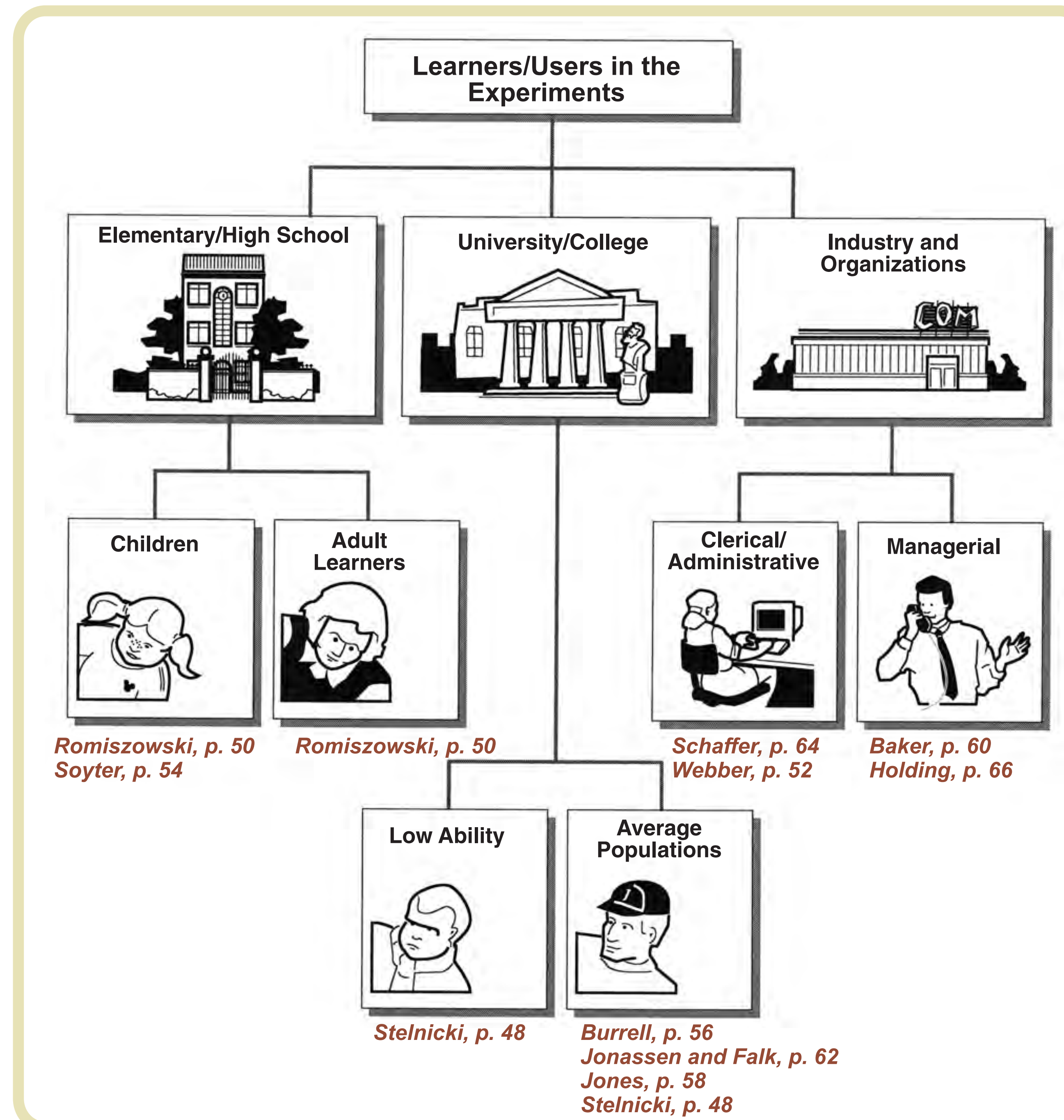
Introduction

Continuing the overview of research summarized in this chapter, we look at where the research was conducted, and who the subjects were in these studies.

The research reports are referenced by the name of the investigator along the bottoms of the charts.

Here's the Actual Order of Pages in This Chapter:





Stelnicki: Both Facts and Abstract Concepts Learned More Efficiently

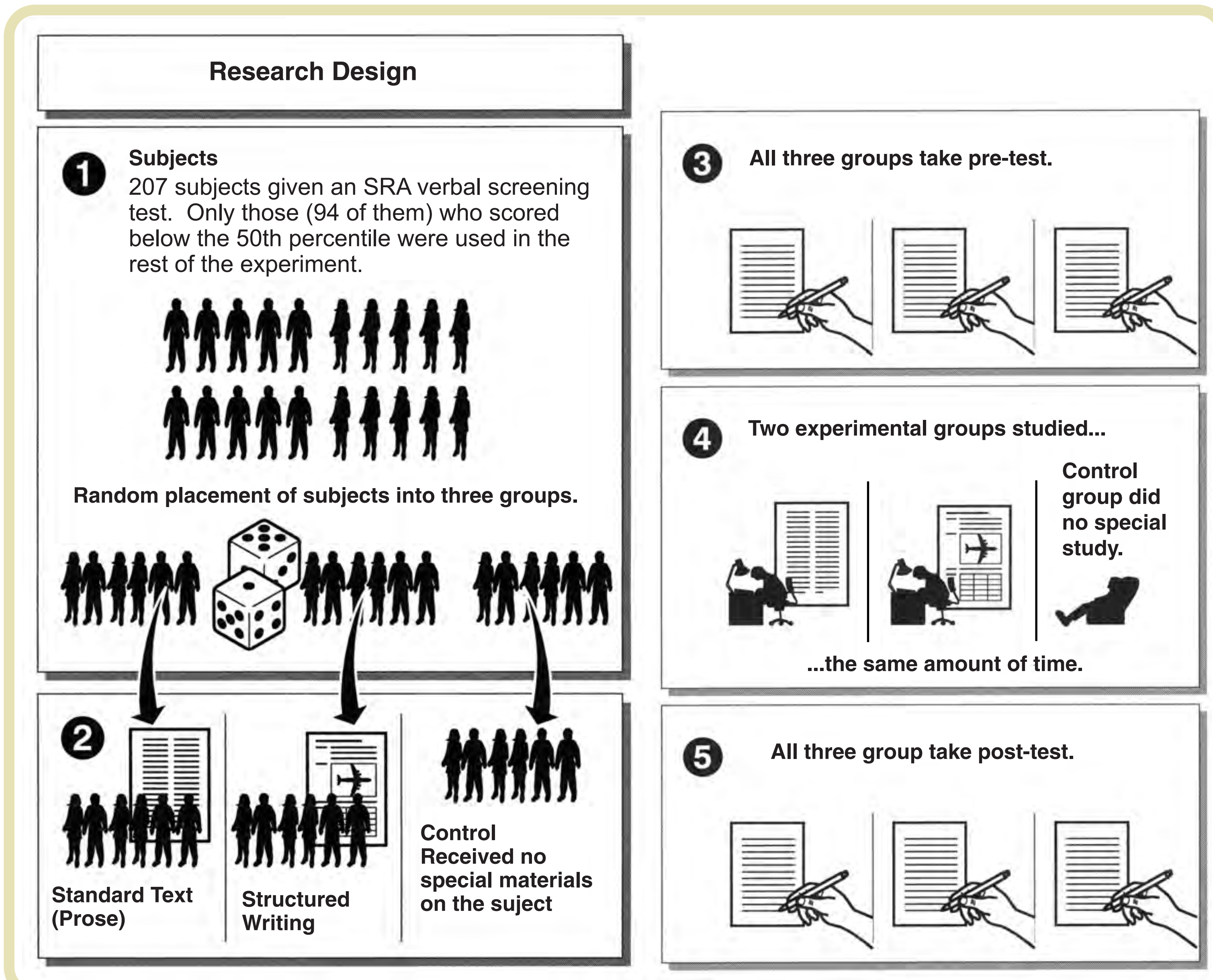
Problem
Can college students learn both facts and abstract concepts more effectively and efficiently using material prepared with Information Mapping's structured method than they can with material in normal prose?

Materials Used
The materials were designed to teach facts and concepts about Piaget's four states of cognitive development.

Task
The administration of 2 tests, one on fact learning and one on concept learning, specifically tied to the learning materials the students studied.

Method of Presenting Task
The 94 subjects were randomly divided into 3 groups:
- those who received standard texts,
- those who received structured writing, and
- those who were control subjects

Subjects
There were 94 subjects at three public midwestern universities participating in the research. They were:
- 81% were female, and
- 19% were male.



The subjects
- scored at or below the 50th percentile on the SRA Verbal Form
- ranged in age from 18.3 years to 52.3 years, and
- had a mean age of 19.8 years

The subjects were in a "low general ability category" by the SRA measure.

Results
Material prepared according to Information Mapping's method produces higher gain scores than the standard text.
Magnitude:
For the retention of facts, Information Mapping's method was better by 32%.
For the retention of concepts, Information Mapping's approach was better by 41%.
Significance: Yes.

Conclusions
Stelnicki's research shows that structured writing containing facts produces higher gain scores than standard text. This implies that concepts generate higher gain scores than all other combinations of methods, and that structured writing is a superior method when used for teaching concepts.

Author and Affiliation
Michael Stelnicki, Northern Illinois University.

Citation
The Effects of Information-Mapped and Standard Text Presentations with Fact and Concept Levels of Learning on Low General Ability Adult Learner Cognition. Unpublished Ed.D. dissertation, May 1980.

Romiszowski: Both Children and Adults Learn Mathematics Better in Less Time

Problem
The question asked was: Which is the better method of preparing instructional materials in mathematics for children and adults-traditional linear programmed instruction, or structured writing prepared with Information Mapping's method?

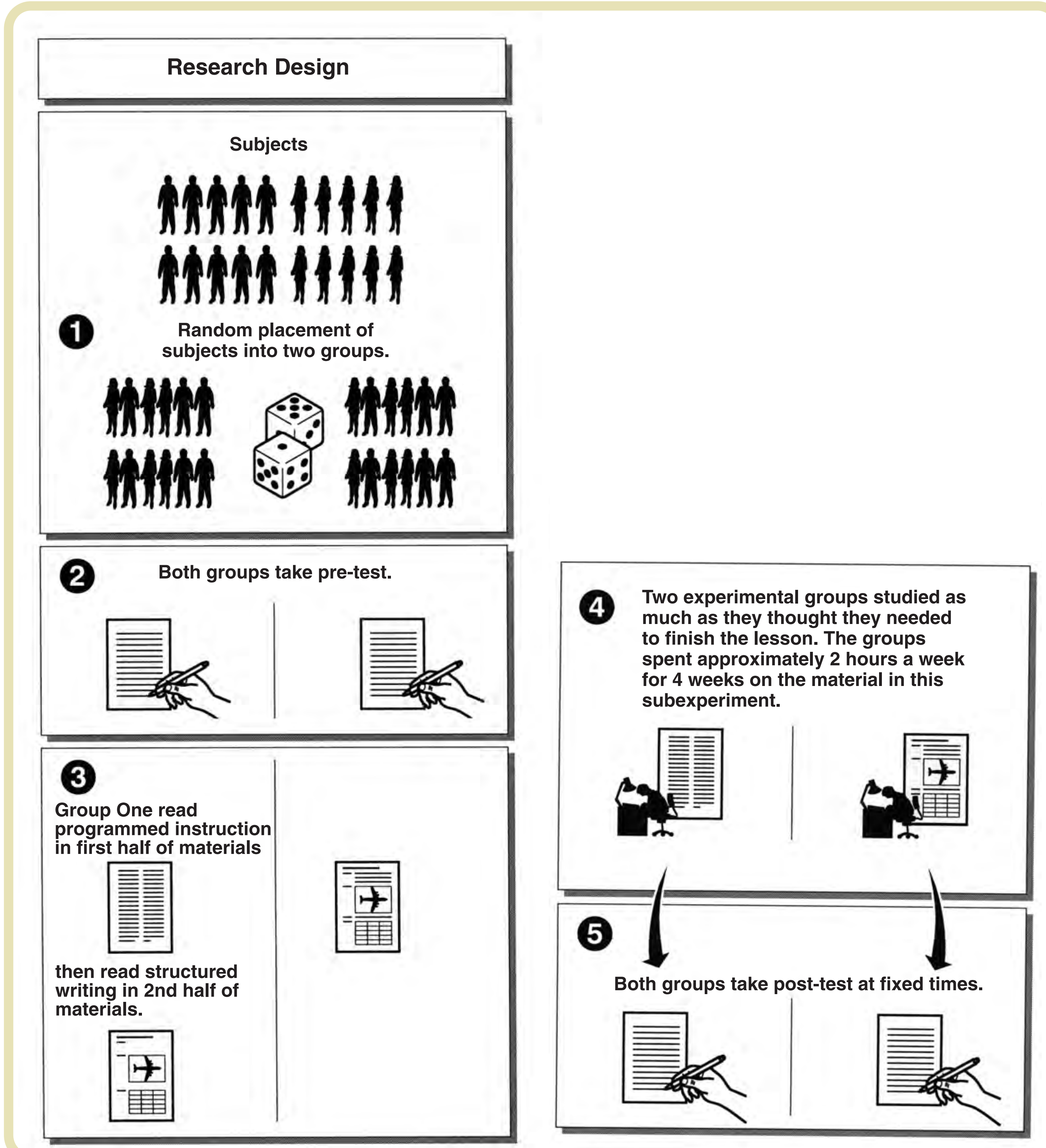
Materials Used
Two sets of booklets were prepared having:
- similar content (the content was as close to identical as possible in both)
- identical sequence
- the same examples
- nearly the same number of words.

The Information Mapping version had approximately 16 maps and approximately 22 pages of feedback and practice exercises.

The programmed instruction version had approximately 25 frames "not typically Skinnerian, but rather more challenging in terms of the amount of information the frame might present." It was a "typical demonstration/practice test sequence of linear frames."

Task
A test on mathematical problem-solving of about 40 questions was used for the subexperiment. The exam tested "medium length [to] long term retention." The exams were standard tests that had been developed for the Brazilian state school system.

The experimental material was on the topic of factorization, and appeared within the context of a larger course. The investigator prepared 2 sets of instructional booklets to use during part of the course- one set in traditional, programmed instruction, and one set in Information mapping's method.



Subjects
A total of 160 children and adults in Brazil were subjects of the subexperiment:
- 15-16 year old advanced secondary students who had not studied mathematics for at least six months, and
- 20-30 year old adults who were attempting to complete high school.

Note: Some of the adults had been away from school for five to ten years.

Results
Magnitude: Both adult learners and schoolchildren learned significantly more from instructional materials written according to standards of the Information Mapping writing service and spent approximately 10% less time than students who used a programmed instruction version.

The adults, on the whole, had 11.3 percent higher scores, and the children had an average of 6.6 percent higher scores.

Significance: Yes.

Conclusion
"The results of this experiment (which was conceived as four subexperiments, each of cross-over design-2 by 2 square) were in all four cases apparently strongly in favor of the Information Mapping format, in terms of both reduced learning time and increased final test score."

Other Findings
The students performed consistently and significantly better on the parts of the test for which they used structured materials in both groups.

Students who used structured materials not only performed better on the test, but they also needed less preparation time.

Author and Affiliation
Alexander Joseph Romiszowski, Ph.D., Loughborough University of Technology (U.K.), now at Syracuse University.

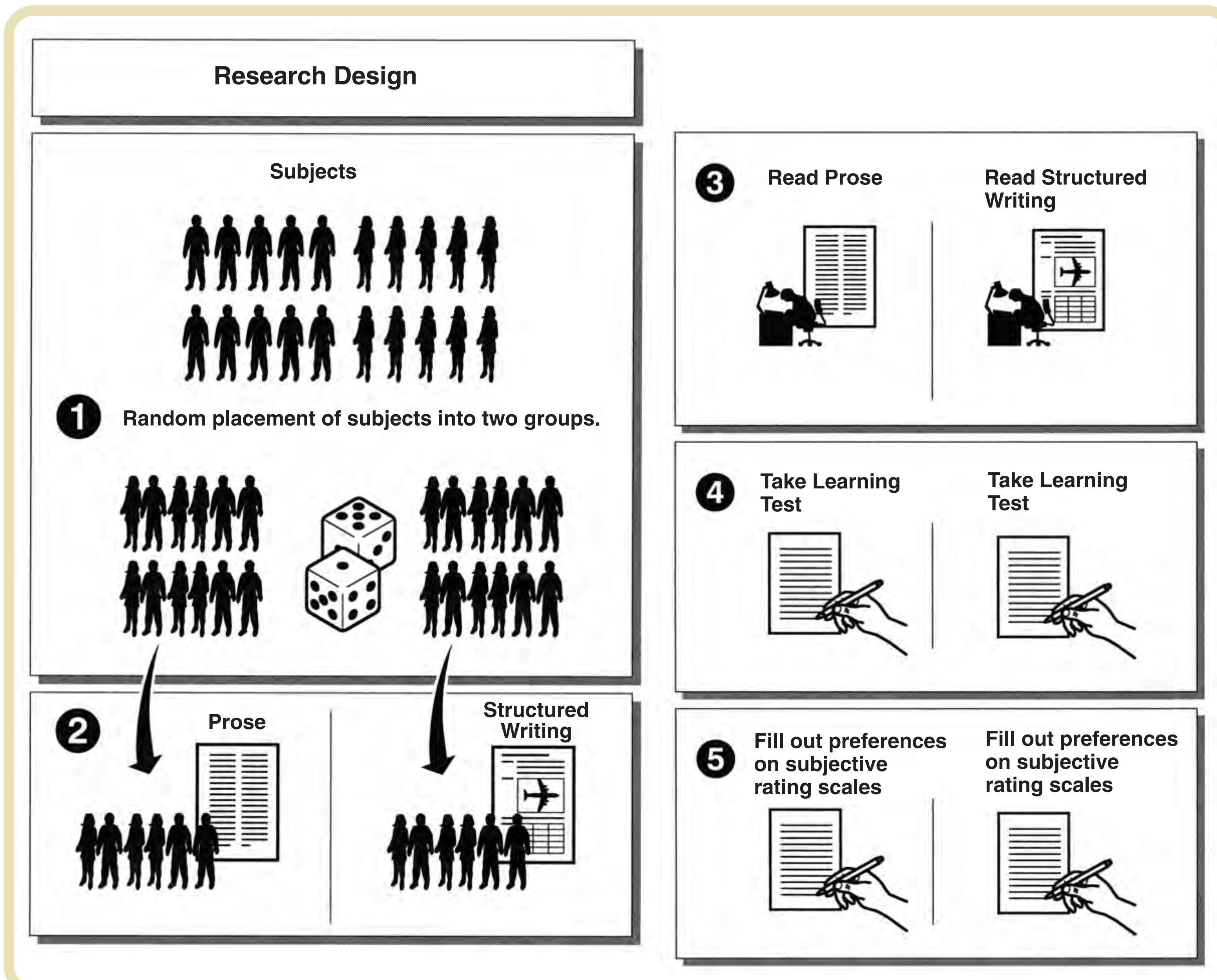
Citation
A Study of Individualized Systems for Mathematics Instruction at the Post Secondary Levels. Ph.D. dissertation, 1977, Loughborough University of Technology (U.K.).

Webber: Improves Initial Learning and Reduces Training Time by Structured Writing

Problem
Is the Information Mapping method of preparing training material better than the conventional methods?

Materials Used
A set of standard training materials and a set of materials prepared using Information Mapping's method.

Task
Functional Accounting Coding Tasks.
Subjects Administrative and clerical employees of Pacific Bell. (No further information in the report.)



Results
Magnitude:

Factors \ Treatment	Information Mapping	Standard Mapping
Lesson Test: Average Scores	95%	75%
Criterion Test: Average Scores	91%	53%
Percentage of learners achieving 88% or above accuracy in • Lessson Tests • Criterion Tests	 95% 83%	 30% 0%
Course Length	1 day	1 day

Significance: No test reported.

Conclusions
Initial Learning: Learners using instructional material writ- ten using Information Mapping's method scored 38% better on criterion tests as compared with a similar group using standard training material containing text and questions.

Training Time: Learners using the Information Mapping version took an average of 1 day in self-paced learning mode as compared with 2 days for the learners using standard training-a 50% improvement in training time.

Attitude: Eighty percent of the MAP learners felt the training was "fairly easy to easy" as compared with 60% of the learners with standard training.

Ninety-five percent of MAP learners felt "fairly well to well prepared and confident" at the end of training as compared with 44% of the learners using the standard training materials.

Other Findings
"The performance level back on the job has been very good. We've seen them start out on the job making 85% accuracy to start out with, and within the month they're moving up into the 90s in on-the-job performance."

Author and Affiliation
Naomi Webber, Pacific Bell.

Title
Some Results of Using the Information Mapping Writing Service Standards at Pacific Telephone Company, paper given at national conference of the National Society for Performance and Instruction,

Soyster: Better Achievement in Instruction Research Design

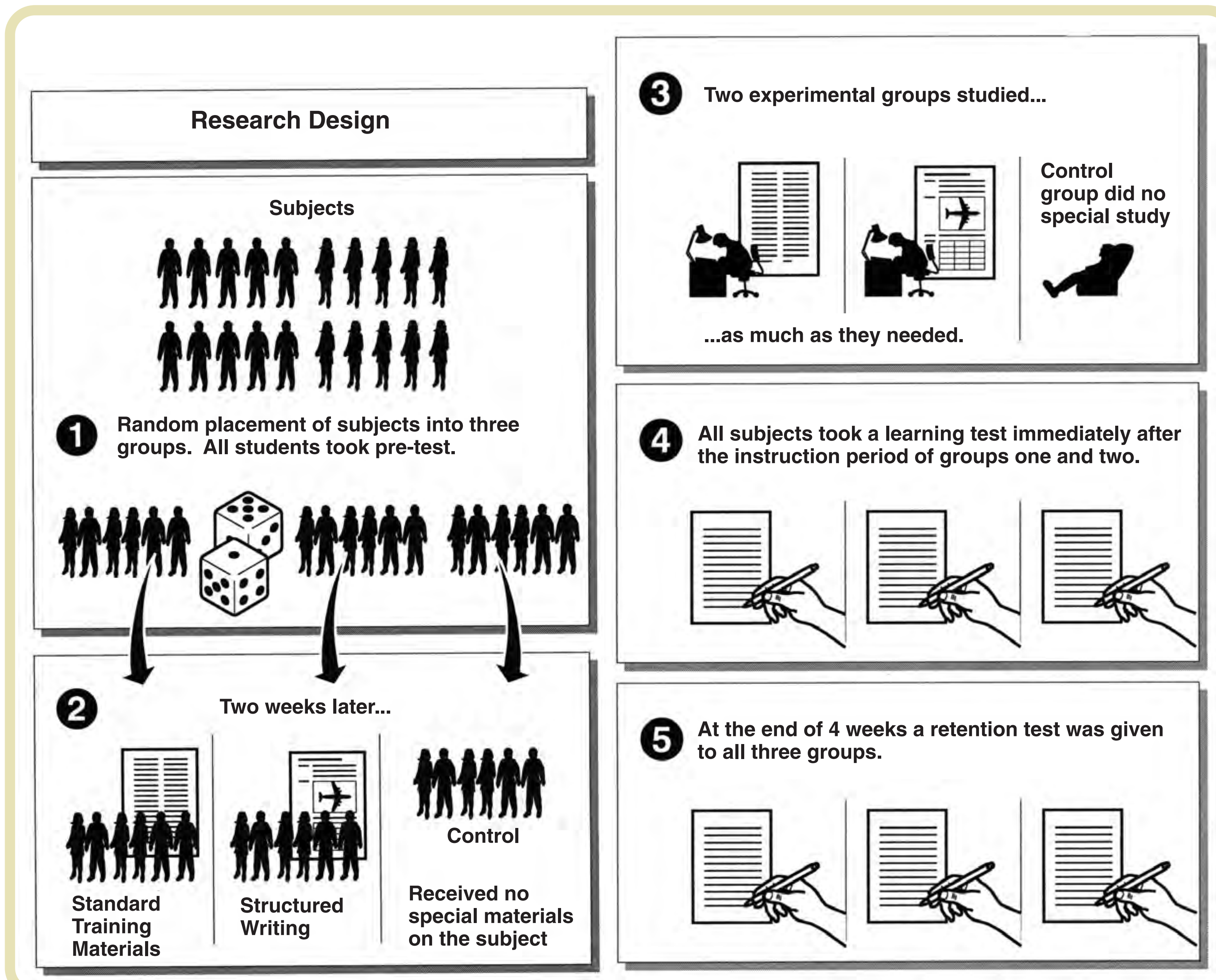
Problem
Does Information Mapping's method of structured writing and instructional design produce better learning and retention than a standard method of training?

Materials Used
Two versions of an instructional course on hydraulics: one using Information Mapping's method, the other using a standard method of self-instructional training delivery resembling programmed instruction.

Task
Two tests were given, one testing initial learning and one testing 4-week retention

Subjects
367 ninth-grade students (194 males and 173 females).

Initial Screening: Any potential subject who scored 50% or more on a screening test on hydraulics was eliminated.



Results
Magnitude: The group using Information Mapping's method performed 13% better than the the group using the programmed instruction in the test scores.

Significance: Yes.

Other Findings
Neither auto-instructional method produced significantly higher achievement on learning or retention when considering only high or only low mental ability subjects.

Consequently, there does not appear to be an aptitude- treatment interaction between either method and high or low mental ability.

Conclusions
The investigation yielded these findings:
Students who received instruction had significantly higher mean achievement scores than the control group when tested immediately.
Students who used Information Mapping's structured writing scored significantly higher than students who used the standard training method materials when tested immediately.
There was no significant difference between the students using either method when retention was tested 4 weeks after instruction. The researcher attributed this to poor motivation on the part of the learners.

Programmed instruction is effective, but texts written in structured writing produce significantly higher achievement in initial learning tests.

Author and Affiliation
Thomas J. Soyster, Ed.D., Temple University.

Citation
A Comparison of the Effects of Programmed Instruction and the Information Mapping Method of Instructional Design on Learning and Retention of Students of Different Mental Abilities. Ed.D. dissertation, 1980.

Burrell: Significantly Greater Achievement in Critical Care

Problem
How well do students learn from material prepared according to Information Mapping's method compared with regular prose treatment in a self-assessment framework?

Materials Used
Critical Care Course: Nursing Roles in Crisis.
- anatomy and physiology
- synthesis of previous nursing information
- predominantly new information.

Text used: Z. L. Burrell, Jr. and L. O. Burrell, *Critical Care,* 3rd ed. St. Louis: C.V. Mosby Co., 1977.

The students used self-assessment guides written according to Information Mapping's method for one chapter of each of the 3 sets of paired chapters. They studied the other chapters without additional written instructional material.

Task
Administration of a 60-item posttest on the chapters studied.

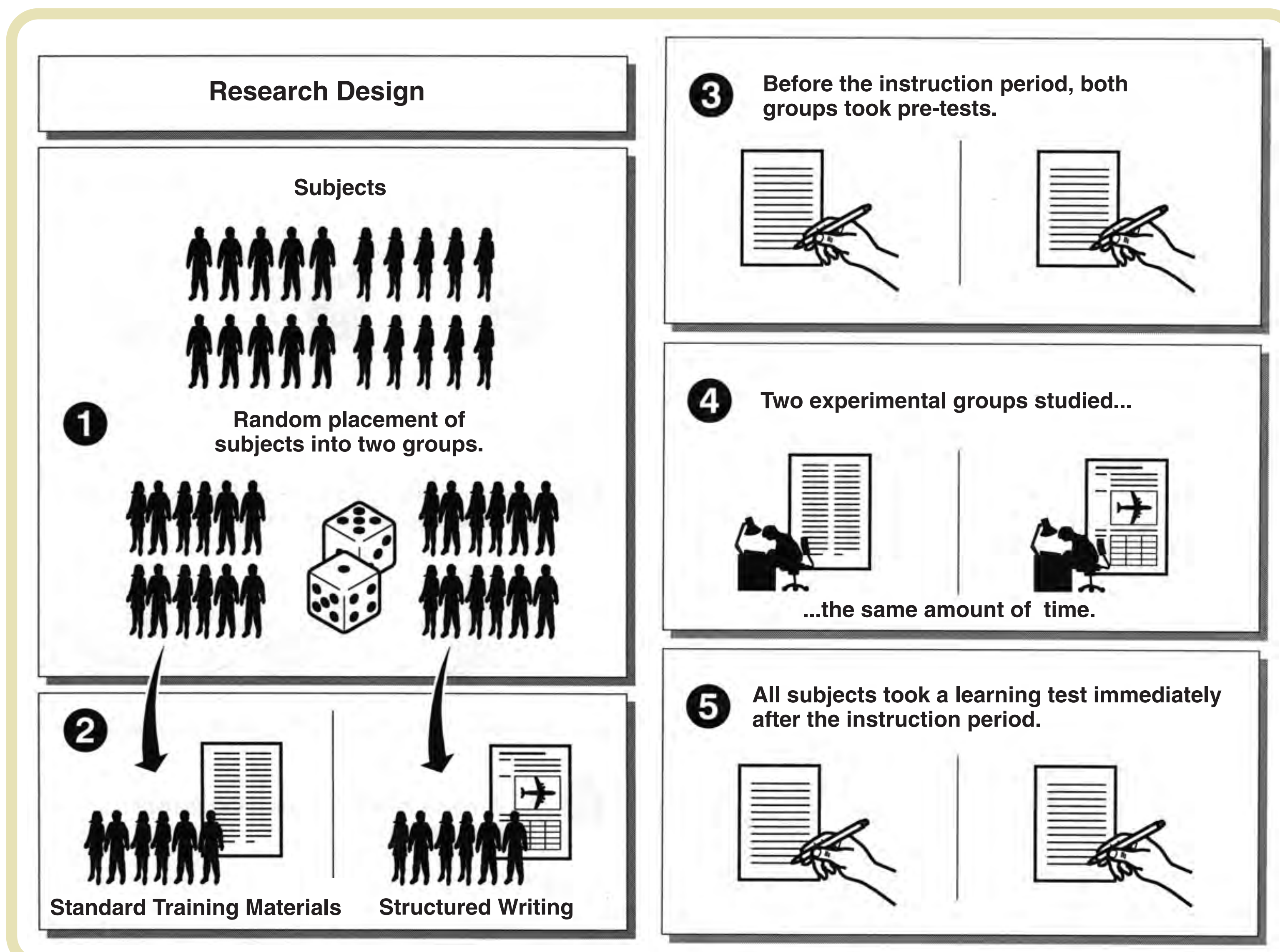
Subjects
39 senior students at the Medical College of Georgia School of Nursing at Athens.

Results
Magnitude:
The "students missed over twice as many questions without the guides when compared to the tests with the guides."

For high SAT score students, the Information Mapping version produced average scores 59% higher than the standard version.

For lower SAT score students, the Information Mapping version produced average scores 53% higher than the standard version.

Significance: Yes.



Conclusions
Students whose scores were above or below the national SAT mean scores using instructional material written according to the standards of the Information Mapping writing service showed significantly greater overall achievement than learners who did not use the instructional material.

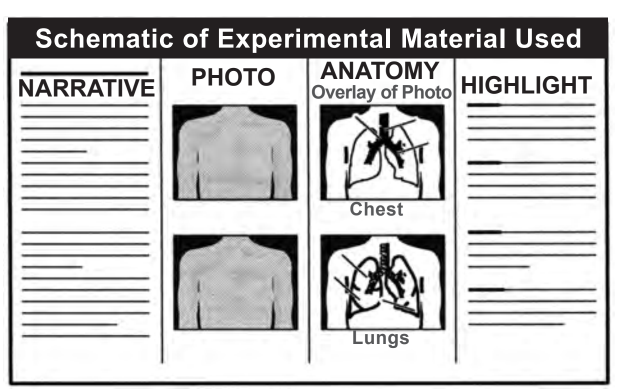
Author and Affiliation
Lenette O. Burrell, R.N., Ed.D., Medical College of Georgia School of Nursing

Citation
Dissertation Abstracts International 1979, 39(12): 71110 A..

Problem
This study asked: (1) Does using Information Mapping's approach increase learning scores, preference ratings, and decrease study time compared with a traditional textbook? (2) Can one distinguish levels of anxiety prior to testing between groups using different versions of learning material?

Materials Used
The traditional textbook used in this course was a "well established third edition" of the Health Assessment Manual (McGraw Hill, 1986) written by the researcher. The prepublication edition of this material was used to keep the author's name anonymous so as not to influence results. A single chapter on doing a physical examination of the thorax and lungs was used in the experiment.

The Information Mapping version was produced in a special 4- column format. "[T]he first column [was] used for verbal presen- tation. Within this column, concepts and definitions of specific aspects of the examination (e.g., the definition of respiration) were presented; the process (e.g., the function of a particular body part) was discussed; and the related procedures (e.g., the step by step process involved in examining the heart) were explained. Visuals were presented in columns 2 and 3 and specifically designed to interface with the narrative prose and reflected the objectives of the information block under discussion. . . . visual designs were created in relation to the overall model of the text and incorporating multiple cuing strategies. . . . the fourth column was devoted to . . . reviewing. Within this column, verbal and visual information was reviewed from the three preceding columns and highlighted, so as to reinforce both narrative and visual informa- tion, thought to be important."



Task
Three test measures were used:

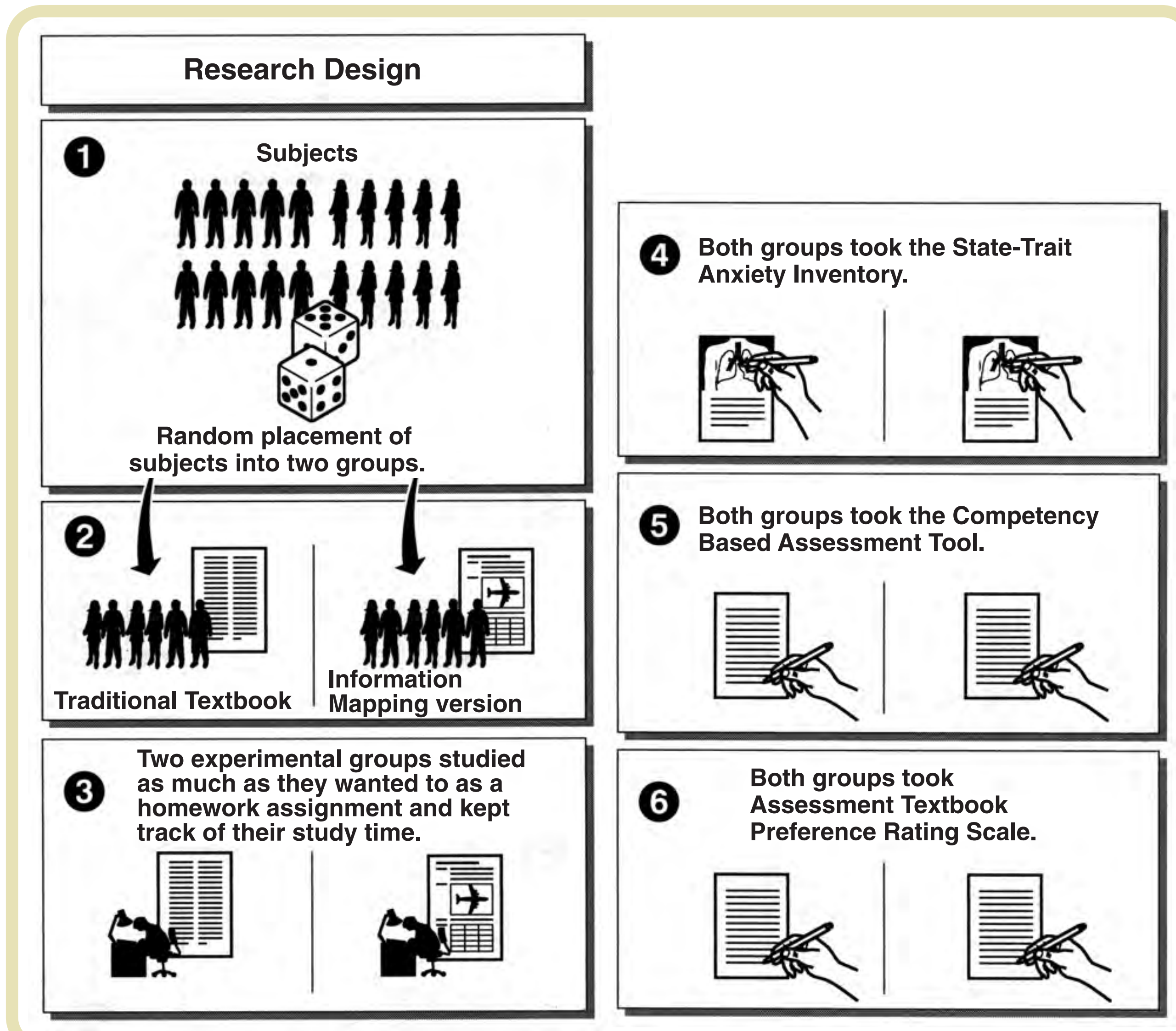
Competency Based Assessment Tool (CBAT) consisting of 50 multiple choice and short answer items. Approximately 50% of these questions contained a graphic element.

Assessment Textbook Preference Rating Scale (ATPRS) to determine student preferences for traditional and experimental textbooks treatments.

State-Trait Anxiety Inventory (STAI) used to measure level of student anxiety immediately prior to testing of the homework reading assignment.

Subjects
The subjects were 70 full-time students at three university nursing schools enrolled in their first nursing course Ages 18 to 31, with a mean age of 20.16 years.

Participation in the experiment was voluntary and did not affect students' grades.



Results
Magnitude: "The results of this investigation further demonstrated that in comparison to the traditional text format, students from all three academic settings who studied from the interactive information mapped text received significantly higher scores on the test of mastery, had significantly higher scores on the text book preference rating scale, and increased their study time."

Learning: The group of students who used the Information Mapping version scored approximately 22% higher in the competency test.

Preference: The students who used the Information Mapping version gave significantly higher ratings to their material over the ratings provided by the traditional textbook group.

Anxiety: There was no significant difference in anxiety immediately preceding the taking of the mastery test. The author attributes this to the fact that the results of the experiment did not influence student grades.

Learning Time: "[S]tudents who studied from the mapped text (60 minutes or less) received higher mastery scores than did students studying from the traditional text (for more than 60 minutes). Students who studied the mapped text for more than 60 minutes received higher scores than those studying the mapped format less than 60 minutes. All student studying from the information mapped text, regardless of study time, had significantly higher scores on the tests of mastery."

Significance: Yes.

Conclusions
These findings support the hypothesis that materials prepared according to Information Mapping's approach "(1) resulted in significantly higher scores on test of mastery; (2) [were] significantly preferred over other text formats presenting similar content; (3) [were] read longer than the traditional format; and (4) increased study time, which significantly influenced mastery scores. . . . In addition, reactions to the interactive information mapped format tended to be more positive and consistent, had greater depth, and contained more individual reactions to the text format."

Author and Affiliation
D. A. Jones, Ed.D., R.N., C., F.A.S.N., Boston University, now at Boston College School of Nursing.

Citation
The Effects of an Interactive Information Mapped Textbook on Mastery Learning of Physical Examination and State Anxiety of Undergraduate Nursing Students, Boston University, Ed.D. dissertation, 1986.

Problem
How does Information Mapping compare with prose and with prose augmented with advanced organizing information in speed of reading and immediate recall?

Materials Used
There were 3 texts used by the 3 groups in the study:
- *Prose.* A text 24 pages long used to train soldiers in the U. S. Army in leadership. It contained a "liberal application of such aids as the use of major topic headings, the insertion of section summaries, and conclusions, and underlining key words."

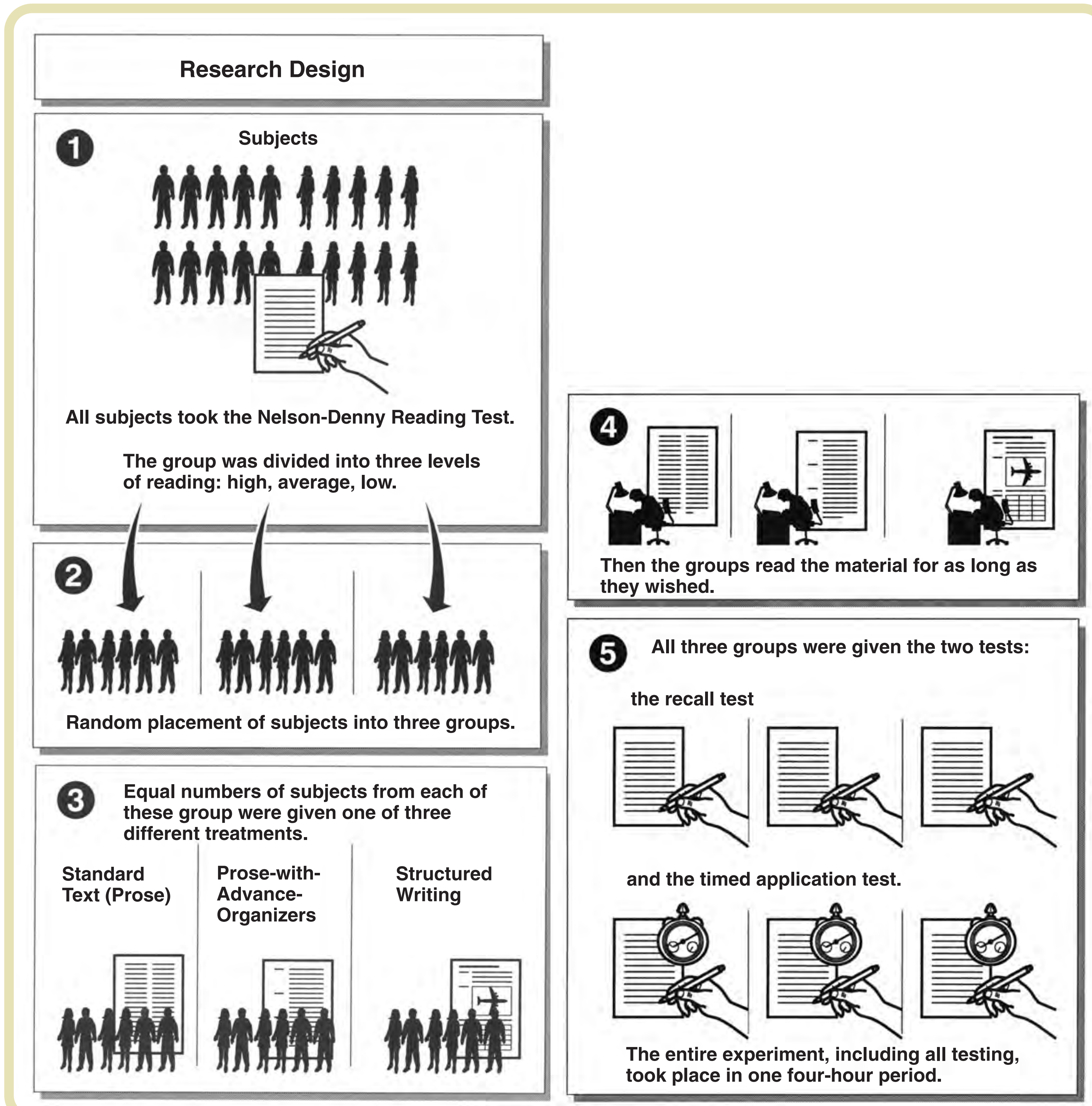
- *Prose-with-Advance-Organizer.* This version contained the prose version with an advance organizer treatment at the very front of the text. The advance organizer was approximately one page long.

- *Information Mapping version* which contained the same number of pages as the prose version (24 pages).

Task
Reading test. The subjects were divided into 3 reading ability groups: high, average, and low, based upon the results of the reading comprehension portion of the Nelson-Denny reading test.

Two post-tests were administered during the sessions:
- a multiple choice recall examination consisting of 33 questions scored on accuracy
- an application examination containing multiple choice questions scored on the basis of time.

Subjects
335 junior officers (266 male and 69 female), primarily second lieutenants, attending Signal Officer Basic Course at Fort Gordon. Ninety-five percent of the officers had previously graduated from colleges and universities.



Results
Magnitude: The three groups did not differ significantly on the scores on either of the tests.

The Information Mapping group did, however, have significantly lower reading times.

1. The Information Mapping group read 12% faster than the advanced organizer or prose group in the high ability reading group.

2. In the average reading level group, the Information Mapping group read 18% faster than the advanced organizer group and 20% faster than the prose group.

3. In the low reading ability level group the Information Mapping version produced 16% faster reading than the advanced organizer group and 21% faster reading than the prose group.

Significance: Yes.

Conclusions
The research showed that subjects who read a text using Information Mapping's method significantly outperformed the subjects who read the prose and prose-with-advanced organizer versions. Subjects in the high reading ability group also significantly outperformed the lower ability readers in reading time, recall scores, and application time.

Author and Affiliation
Edward Isaac Baker, University of Georgia, Athens.

Citation
Effects of Variations in Text Designs and Reading Competency on the Immediate Recall and Application by Army Lieutenants Attending the Signal Officer Basic Course, Ed.D. dissertation, 1988.

Problem
Are materials prepared according to Information Mapping's method better than programmed learning materials for retrieval of information?

Materials Used
Two versions of self-study materials were developed for this experiment from a 2,000-word prose passage, "Communication and the Teaching Process":

Standard Training Method. One version was a 20-page programmed learning text containing 40 frames "of a paragraph or less, and multiple choice questions were inserted after each unit with knowledge of results presented immediately below the frame on which the student was working." Two illustrations (apparently diagrams of the communication process) were put at the end.

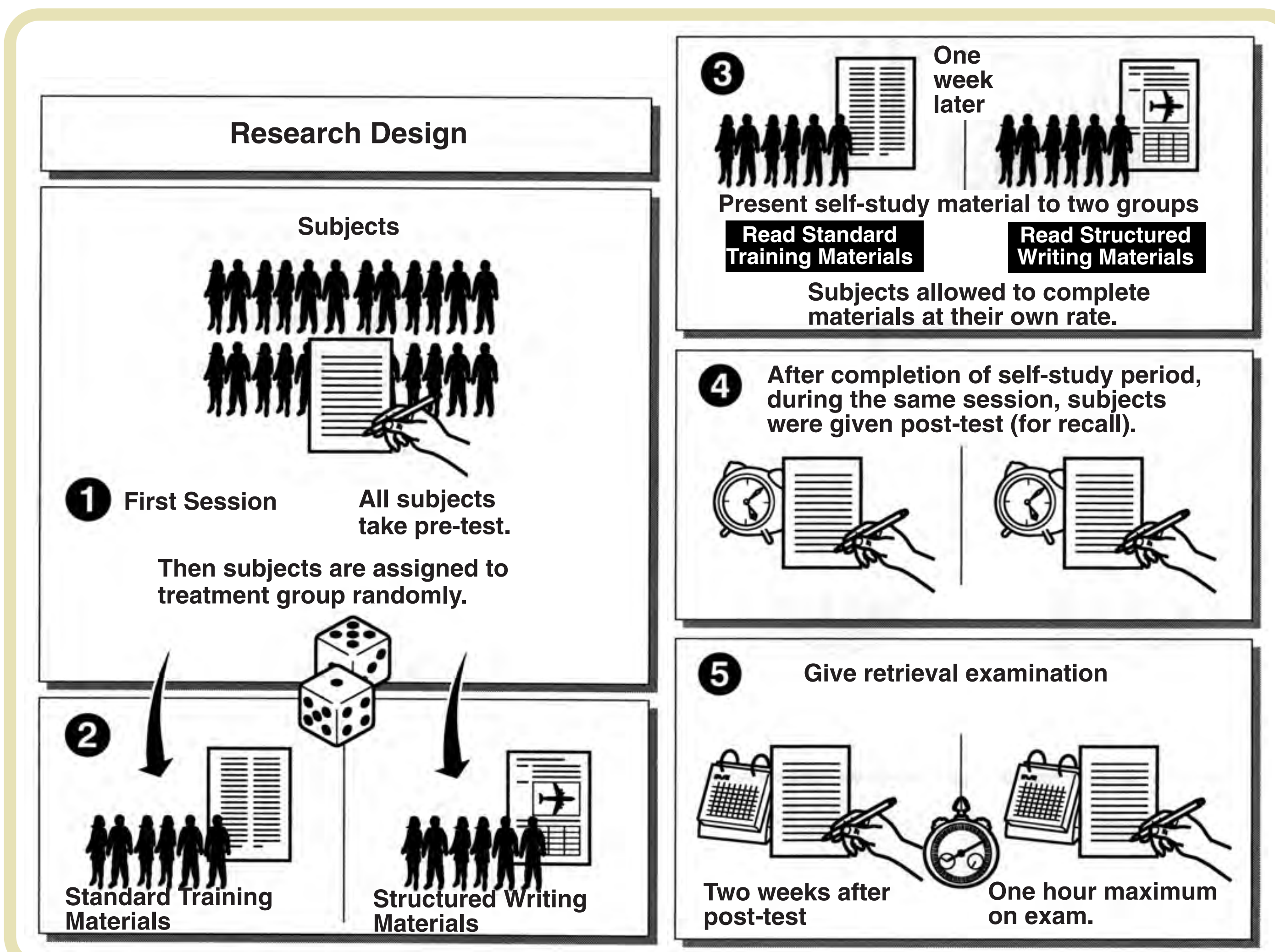
Structured Writing Materials. The version prepared according to Information Mapping's method was a 19-page document which contained 18 information maps, 55 blocks, and the same two illustrations.

Our understanding is that there was active response in both versions.

Task
Pretest /Posttest. (for recall):
- 41 test items
- 4-option multiple choice
- test items extracted verbatim from text
- reviewed for validity by panel of subject matter experts.

Reliability for this exam was established by administering it to a separate group of subjects.

Retrieval Test. (for speed and accuracy of lookup):
- open book tasks
- 45 fill-in-the-blank questions using stems from the pretest-posttest exam
- students were required to write the page number on which information was located
- test administered 2 weeks after the posttest.



Subjects
41 seniors and graduate students in two sections of an introductory media course.

Subjects were divided into two unequal groups:
- 22 used structured writing, and
- 19 used standard writing

Results
Magnitude:

Retrieval. Students using the structured writing version of the materials were 32% more accurate than those using the standard training material. Results were measured in terms of "the total number of correct answers that could be located within one hour."

Initial Learning. The two methods (standard and structured writing) both provided approximately equal initial learning when presented in a self-paced mode.

Significance: Yes.

Conclusions
The structured writing version provided significantly better retrieval of information than the standard training materials. "The structural characteristics of [the Information Mapping version] provide a clear advantage for retrieving information from textual materials," wrote the authors. "This study has proven that Information Mapping is an effective alternative means for enhancing print-oriented textual materials. The instructional effectiveness of mapping has been documented in a variety of settings, including industrial and business training, the military, in the university, and at technical institutes ...The clearest mandate produced by this study is for the use of information mapping techniques in the construction of reference tools."

Author and Affiliation
David H. Jonassen, School of Education, University of North Carolina at Greensboro, and Lawrence Falk, Insurance Company of North America.

Citation
Mapping and Programming Textual Materials, *Programmed Learning and Educational Technology*, 1 (1), February 1980: 20–26.

This research has also been reported in: D. H. Jonassen, *Recall and Retrieval from Mapped and Programmed Text,* paper presented at the AECT Convention, New Orleans, Feb. 1979; and in D. H. Jonassen, *Information Mapping: A Description, Rationale and Comparison with Programmed Instruction, Visible Language,* 1981 15(1): 55–66.

Schaffer: Better Reference-Based Training

Problem
Which is better in a reference-based instruction situation in which the learner has to look up answers in a reference book: Information Mapping's method or standard text?

Materials Used
The **original version** of a 140-page Time Reporting Manual.

"The selection was based upon the high quality of the existing document, its technical complexity, and the size of the user population. The current version has few errors in content and an exceptionally clear writing style. Also, the widespread use of the instruction multiplies the importance of the human performance characteristics of the document."

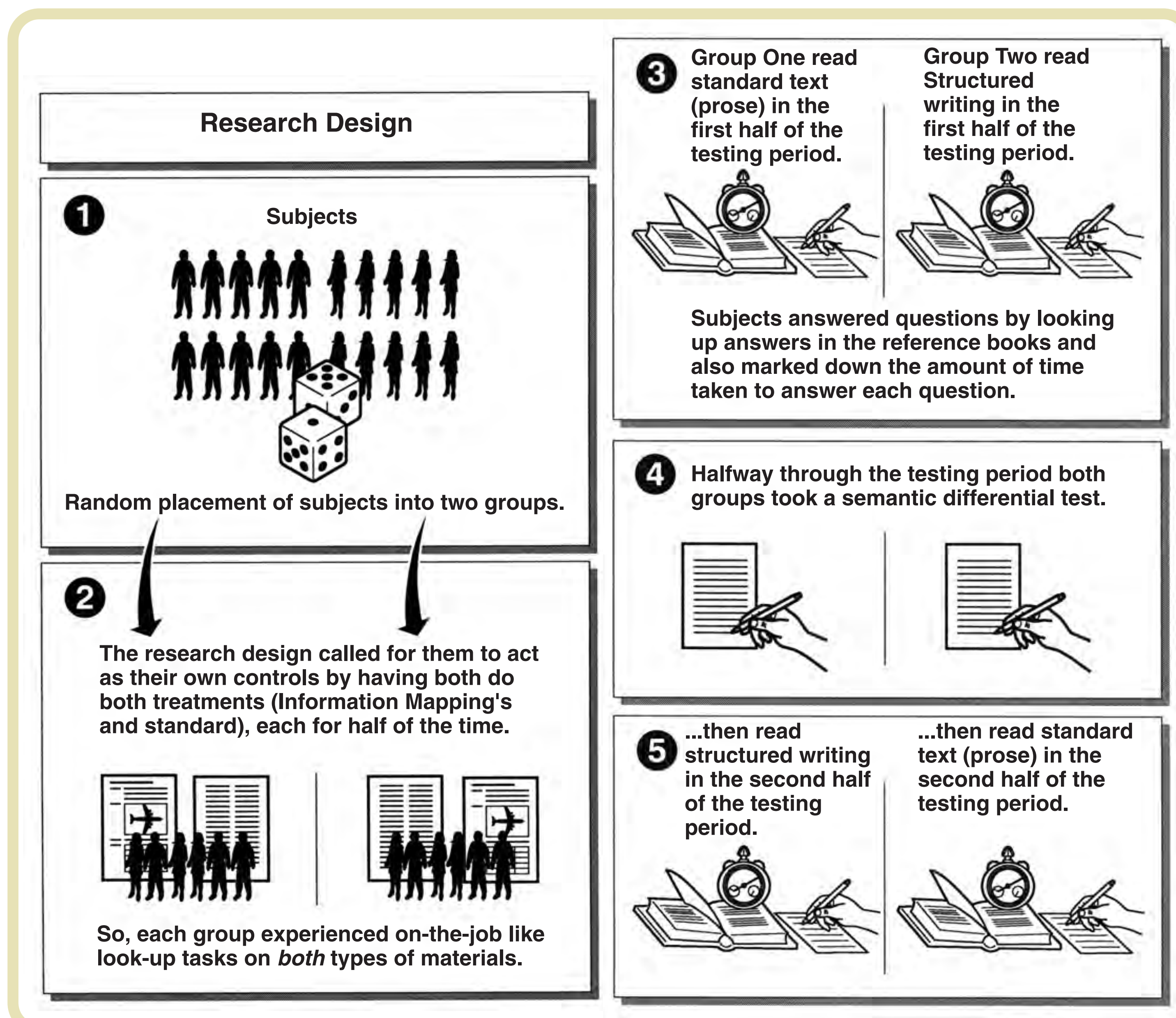
Information Mapping Version. One hundred eighty-five–page revised version developed by Information Mapping, Inc.

Tasks
Retrieval and Application Tasks. "The tasks were generated by randomly selecting time reporting deviation codes from a pool of codes that are not generally known. The selected codes were then inserted at random into one of 2 formats. One question format involved the determination of a code's meaning using a multiple choice presentation. The other question format involved the determination of the appropriate code for a given situation. After each item a space was provided for the subject to record the time. In this way, 2 equivalent sets of tasks were developed, each containing 3 multiple choice items followed by 3 code determination items."

Semantic Differential. A pre- and post-semantic differential evaluation form was provided to subjects to assess perception of task format and feelings about the material.

Subjects
Ten subjects: 7 female, 3 male.
Average Age: 38.6.
Job Type: 5 clerical, 4 management.
Average Length of Employment: 10.2 years.
Knowledge of Tasks: Subjects were screened to prevent inclusion of individuals familiar with the specific time reporting instruction tested on IM.

Analysis
Time and error data compiled. Semantic differential scaled on 1–7 scale.



Results
Magnitude:
Time. The version "had no significant effect on the time required to complete the tasks."

Errors. "Subjects made 54.5% fewer errors in the tasks when using the Information Mapping version of the instruction."

Significance: Yes.

Subjectivity rating: "The Information Mapping version was reported to be more 'modern,' 'clear,' 'not frustrating,' 'friendly,' and 'good.'"

"Of the 25 items on the final evaluation instrument, 12 revealed significant differences between the versions of the instruction ($P < .05$)."

The Information Mapping version was described as follows:
- text rambles less
- divided into more logical parts
- table of contents easier to use
- type font not "too small"
- more "trustworthy" and "friendly"
- made subject feel more "satisfied," "confident," and • "in control"
- "easier to use"
- "easier to learn from"
- more of a "good, quick reference."

Conclusions
"Although the current version is generally considered by management to be in 'good shape,' the Information Mapping version was significantly superior. Although the scope of the study is limited, the importance of writing quality is clearly demonstrated."

Author
Eric M. Schaffer.

Citation
The Potential Benefits of the Information Mapping Technique, NSPI Journal, 1982 (February): 34–38.

Comment: Size of Task

Rarely do studies use reference and training materials of such a large size as those used in this study. This, together with the closeness of the experimental situation with on-the-job use of similar materials, makes this an especially significant study.

Also relevant here is the concept of reference-based instruction for training and on-the-job reference materials. -REH

Holding: Improves Writing of Business Reports

Problem
Did the Information Mapping method of preparing business reports and the course for teaching the method improve the writing skills of managers to such a point that it resulted in improved communication? Did the course reduce the time it takes managers to write memos and reports to such a point that it created time/cost savings for Pacific Bell?

Materials Used
R. E. Horn, Training Course Material for Effective Reports, Proposals, and Memos, taught in a 3-day format by Pacific Bell instructors certified to teach the course by Information Mapping, Inc., Waltham, MA.

Task
Writing reports in an ongoing business setting after the course. Thus, the evaluation measured skills used on the job after training.

Subjects
One hundred eighty first level managers of Pacific Bell.

Results
Magnitude:
Decrease in Reading Time. All of the supervisors surveyed state that the amount of time it takes to read a document, using the method taught in the course, has decreased. The mean decrease in the amount of time was 32% and ranged from l0 to 50%

Improvement of Writing Skills as Rated by Supervisors. Before the course, supervisors rated the skill of the subordinates who took the course on a 7-point scale at a mean of 4.09; after the training, they achieved a mean rating of 6.00. These improvements in skill and similar separate ratings in clarity were attributed to the training course by all (l00%) of the supervisors.

Increase in Report Writing Speed. Supervisors indicated that the writing productivity of the subordinates increased.

Improvement in Analytical and Organizing Skills. All of the supervisors also said that the course improved the analytical and organizing skills of the attendees.

Significance: Not reported.

Research Design

1 Subjects

Pre-course Data Collection. **Before the course was given, each participant submitted:**
- **data on prior training in writing**
- **self-rating on personal writing skill**
- **self-rating on clarity of one's own writing**
- **rating on clarity of other people's writing.**

2

Pre-course Supervisor Rating. **Before the course was given, supervisors of the trainees submitted:**
- **a rating of the subordinate's writing skill, and**
- **a rating of the subordinate's clarity of writing.**

3

The Course Taught in Writing Reports. **Certified instructors of the structured report writing methodology taught a three-day training course in a classroom setting.**

4

Writing Apprehension Quiz. **During the course, the Writing Apprehension Quiz was administered three times:**
- **on the day the course started**
- **at the end of day three of the course, and**
- **one month or more after completion of the training**

5

Post-Course Supervisor Rating. **After the course, the participants:**
- **rated themselves on writing skill and proficiency**
- **rated themselves on clarity of writing**
- **rated the clarity of other's writing**
- **estimated the effect that the training course had on their writing, and**
- **rated the overall effectiveness of the training course.**

6

Post-Course Supervisor Rating. **After the training, the supervisors of the participants submitted:**
- **a rating of the subordinate's writing skill**
- **a rating of the subordinate's clarity of writing**
- **a determination of whether improvement occurred**
- **a determination of whether time was saved as a result of improvements due to the training, and**
- **an overall rating of the effectiveness of the course in report writing.**

Other Findings
Speeds up Organizational Processes. Eighty-three percent of the supervisors reported faster approval rates due to the methods used in the course.

Subjective Impression of Writing Faster and Saving Time. Eighty-six percent of the first level managers who took the courses reported that the training either saved some or much time in writing letters, and 84.8% thought that it saved time writing reports. Thus, they agreed with their supervisors in this productivity measure.

Completed Report Writing Before Deadlines. The attendees also generally confirmed their supervisor's impressions that they wrote their required letters and memos before deadlines, suggesting that the course did have a positive effect on their writing behavior.

Perceived Increase in Skill. Participants perceived a significant increase in their skill that was directly related to the methodology taught in the course. The correlation between the ratings that participants gave themselves and those given by the supervisors was high. There was a corresponding correlation to the ratings that participants and supervisors gave in improved clarity of writing. A separate inspection of the prior training that participants had in writing revealed that this did not affect the ratings on perceived proficiency.

More Complete Analysis. Analysis of the data also showed that communication written using the method is more complete than that written in the traditional way, substantiating claims made by the developers of the method and course.

High Effectiveness Rating to Course. The overall ratings given by the supervisors to the course were:
- very effective, 63.0%
- effective, 29.6%
- somewhat effective, 7.4%
- not effective, 0%

Author and Affiliation
Eva Holding, Pacific Bell.

Citation
An Evaluation of the Effectiveness of the Information Mapping® Methodology and "Effective Reports, Proposals and Memos." San Francisco, CA. Pacific Bell, Oct. 1985.

Summary

Introduction

The reader who has examined the results of the studies summarized in the two chapters will conclude that there are a variety of different ways to look at the quantitative benefits of using Information Mapping's method. On these pages we summarize the results from this chapter.

		Measured by Number Right or Number of Errors	Time to Do Task	Supervisor Appraisal
Initial Learning	Immediate Recall	**STELNICKI:** 32% higher scores on facts; 41% higher on concepts **SOYSTER:** 13% higher scores **ROMISZOWSKI:** 10% higher scores **BURRELL:** 53-59% better on tests **WEBBER:** 38% higher scores on the criterion texts	**ROMISZOWSKI:** 10% faster **WEBBER:** IM version was 50% faster	
	Long Term Recall	**SOYSTER:** No difference (attributed to motivation factors by the researcher) **WEBBER:** IM version provided 85% or better accuracy when starting on the job		
Retrieval	Had Previously Used the Materials	**JONASSEN AND FALK:** 33% higher scores with IM	**BAKER:** IM had 12-21% better reading speed	
	Had Never Seen the Materials Before	**SCHAFFER:** 54.5 fewer errors with IM		
On-the-Job Application			**HOLDING:** Supervisors reported 32% decrease in reading time for persons receiving reports written in IM. 84% of IM users report increase in writing speed after taking course	**HOLDING:** Supervisors reported 100% of those who received training had productivity increase. Course was rated: • very effective 63% • effective 30% • somewhat effective 7%

KEY
IM = Information Mapping's method

*The Soyster results on long-term recall may reflect nothing more than what much research has shown about memory, i.e., that human beings forget at a rapid and constant rate no matter how they learn. The only exception to this general condition is that people remember material they use frequently or that they learn to a level of fluency. Soyster's subjects learned to a "just barely can do" level and did not use the material in the intervening time. (For this reason, we recommend the use of "reference-based training," that is, training based on the immediate recall and retrieval properties of Information Mapping's method. Reference-based training is also sometimes referred to as "just-in-time training.")

notes

Chapter 1. Evaluating the Method

2. Overview of Research Results. For a comprehensive look at evaluation in an industrial training situation see Smith, 1980.

6. Effectiveness: Does It Work at All? For a description of this research, see Horn et al., 1969. Other researchers who have done effectiveness research are Cheung (1980), Fields (1982), Reid (1984), Mcclung (1985), and Olivares-Guerrero (1985).

8. Comparative Effectiveness: How Does It Work Compared to Other Approaches? Research mentioned includes Stelnicki (1980), Jonassen and Falk (1980), Romiszowski (1977), and Soyster (1980). Descriptions in the text in this and following pages may be located in the References section under the name of the researcher.

10. Business Effectiveness: How Well Does It Work in Real-World Business Situations? Studies referred to are Webber (1979), Shaffer (1982) and Sherman (personal communication).

12. User Acceptance: Do Users Like It and Use It? "Test in Statistics Class" see Horn et al., 1969. Pacific Bell anecdote (personal communication).

14. Teaching Effectiveness: Can You Teach It to Others Consistently? Data from reports of instructors from Infor- mation Mapping, Inc., and from Pacific Bell, AT&T, Boeing, DEC, and Canada Bell. "Romiszowski and Horn Report," both of the matrix algebra manuals are unpublished manuscripts. See Horn, 1985, for another account of the same data.

16. What Other Operating Characteristics Do You Find? Quotes are from Bixler, 1979.

18. Does It Work under Difficult Conditions? All of the data from Information Mapping's clients. "One of the largest real world situations ..." and "One of the Largest Personnel Manuals ..."; unfortunately, I can't cite more information because of non-disclosure conditions.

20. Scaling Up and Scaling Down: Does It Work on Large as well as Small Projects? Data from Information Mapping, Inc. survey (unpublished data).

22. Does It Work in Very Constrained Situations? "Some Typical Applications of Information Mapping's Methodology to Online Text." Data from survey of Information Mapping, Inc. project managers (unpublished data).

26. Does It Work in Special Training Situations? These 2 pages are based on an article by David Grebow and Robert E. Horn, "How Training Helped Wells Fargo Sell a New Service." Available from Information Mapping, Inc.

28. Besides All That Efficiency and Effectiveness, Can You Provide an Attractive and Comfortable Journey? Example 3 from Horn, 1989 (used with permission).

30. Does It Increase Productivity? Data from La Boissier (personal communication).

32. Is It Cost-Effective for Its Mission? Information Mapping has a publication that helps you estimate costs and benefits. Ask for *The Bottom Line.*

36. Can You Measure Critical Variables in Its Components? The relative numbers of examples and definitions are exemplary. Each subject matter would have slightly different measurements.

Chapter 2. Research on Information Mapping's Method

General note on Magnitude and Significance. The reader who has examined the References will note that we have included blocks on magnitude and significance for each research report. Under magnitude, we report the size of the differences noted. Under significance, we indicate whether the researcher reported statistical significance for his/her findings. Statistical significance is concerned with whether the difference found in the research is reliable. Even a small magnitude (difference) may be reliable, while a seemingly large difference may sometimes not be reliable (i.e., statistically significant). In most research the minimal level of significance is .05 meaning that not more than 5 times in a hundred would these results occur by chance.

44. Overview of this Chapter: Abstracts of Research. The reader who has examined the References will note that we have not abstracted all of the dissertations that have been done on Information Mapping's method. There are several reasons for this. There are some duplicate findings. For example: Cheung (1980), Fields (1982), Reid (1984), Mcclung (1985), and Olivares-Guerrero (1985) simply confirm and add further support to a positive answer to the question (in Chapter 1) of "Does It Work?" and to the question of how it works on difficult subject matters. Skelly (1982) does not focus on the type of research questions we discuss in this chapter. Rather, he uses Information Mapping's approach as a baseline for several treatments of advance organizers. Tanenbaum (1988) similarly focuses on the question of inserting postquestions and the giving of feedback while using Information Mapping's approach as the baseline for different treatments. Hauck (1985) focused on possible differences between left-brain, right-brain, and integrated learning styles.

58. Jonassen and Falk: Provides Significantly Better Retrieval. Another study by Falk (1981) did not reproduce these results. For analysis, see Horn, 1991, in which I analyzed the Law of Getting No Effect (and, hence, making no significant difference) with respect to information retrieval, namely, anybody can retrieve anything from a small enough document, given an unlimited amount of time.

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I would like to thank all of those researchers who have devoted so much time and effort to the investigation of Information Mapping's method. And I'd like to thank all of those dissertation supervisors who worked with their graduate students to accomplish this splendid research.

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Robert E. Horn
April 1991

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index

CONTINUED ON NEXT PAGE +++

index

continued

Other Papers 1992-95

Clarifying Two Controversies About Information Mapping's Method

by Robert E. Horn

Introduction

As the world has grown more complex, the problems of communication in today's technical and business environments become increasingly demanding. Vast challenging technical products, service, and administrative and managerial subject matters, diverse multi-lingual, multinational organizations - all present new problems for managers, technical and office personnel and other professionals. Documents, on paper and presented on the computer screen, must communicate effectively and efficiently. They must be prepared rapidly and often revised and updated frequently. Information Mapping's methodology for the analysis, organization, sequencing, and presentation of information was developed over two decades ago to meet these challenges.

As Information Mapping's method reaches its twenty-fifth birthday, I have taken the opportunity to discuss its aims and its accomplishments (Horn, 1991a). While the method has been extraordinarily successful in its handling of large complex training and documentation projects as well as routine communications assignments (Horn, 1989), it has not been without some controversy.

In the ongoing rush of guiding the rapid growth of the company that distributes the method, I have not always taken the time to provide answers to questions raised by academic commentators and to rebut certain critiques. I wish to do so in this article.

This paper is divided into two parts: (A) an introduction to the principal components of the methodology and, (B) a section that rebuts the major criticisms that have been made of the methodology through the years.

Section A. The Three Major Parts of the Method

The research on the method has focused on the a three part approach of (1) content analysis, (2) project life-cycle synthesis and integration of the content analysis, and (3) sequencing and format.

Content Analysis

The content analysis side of the methodology focused on devising a taxonomy and criteria for a new set of the smallest practical unit of meaning for writing documents. Initially this work focused on the domain of relatively stable subject matter. (Horn, et. al. 1969) Since then other domains have been explored and appropriate taxonomic approaches proposed. (Horn, 1989)

This work differed from the approaches to modularity taken by others in that it focused on a deep understanding of the basic units of the subject matter. It approached the problem of modularity with the goal of teaching writers easily and with great uniformity to sort sentences and diagrams of a subject matter into an easily understood taxonomy. This required the definition of a new basic unit of information for chunking information, called "information blocks". Initially we defined approximately 40 blocks but in the twenty-five years since then over 200 have been specified for particular documents.

The sorting was facilitated by the discovery of an underlying structure of subject matter called the information types that clustered the "information blocks" into seven information types in relatively stable subject matters. Information Mapping's method was not the first to incorporate the concept of modularity into technical and business writing. (Note 2) But Information Mapping's method can claim to be the first to to define and develop a precise modular concept ("information blocks") that are firmly grounded in a taxonomy of information types. (Note 3)

Let us examine both the concept of modularity and then the concept of information types. It will be useful for the reader who is unfamiliar with the method for me to give some explanation of the concept of a finite group of precisely specified block types.

What are blocks? Information blocks are the basic units of subject matter in Information Mapping's analysis. They replace the paragraph as the fundamental unit of analysis are presentation. they are composed of one or more sentences and/or diagrams about a limited topic. They usually have not more than nine sentences. They are always identified clearly by a label. Information blocks are normally part of a larger structure of organization called an information map which can be defined as a collection of one to nine blocks all related to a specific topic. In short, they are a reader-focused unit. There is something fundamental about this taxonomic approach. The information block scheme has proved capable of first-pass sorting of 80 percent or more of the content of virtually every subject matter that it has been applied to in the domain of relatively stable subject matter. Thus, it can be said to capture and sort the "core" sentences of the subject matter.

An unending sequence of structured information blocks would fail to provide readers with natural and logical ways to cluster important concepts, procedures, processes, etc. It would be little better than an endless sequence of gray paragraphs one after another. To solve this problem, the method was also the first to develop and incorporate the concept of the information map, as a collection of one to nine information blocks. This provides an important intermediate level of specification of document organization. It enabled the clustering of blocks all related to a topic (and where possible an information type) together and to suggest an appropriate labeling system for them. (see below for further discussion of labeling) It was also first to link the idea of the information map with the seven information types. (Horn, 1969)

This whole approach has been called structured writing and Information Mapping's methodology both pioneered the field of structured writing and is the one that has consistently led it in synthesizing the research into a workable tool for analysts and writers.

Life-Cycle Integration and Synthesis

The content analysis is integrated with various planning approaches into a life-cycle methodology for writing projects. It has been refined to incorporate efficient recursive procedures for ensuring, in so far as humanly possible, that all relevant subject matter would be gathered from the subject, thus providing for an approximation to completeness criteria.

The life-cycle integration has been elaborated to facilitate document writing projects at every level of detail and size from the office memo to the largest and most complex documentation projects encountered by industry and academia.

Getting the content analysis complete and appropriately divided and tagged early in the initial analysis phase contributes to efficiency all along the way in the document life-cycle. In particular, it helps specify what information is

missing at any given time in the process. Because the content analysis categories correspond to the deep structure of the subject matter, a systematic way of labeling the content is possible.

Sequencing and Formatting

The third broad area in the method is the ability to specify sequencing precisely and the ability to devise very effective formats for presentation of information complementary to the content analysis system.

Prior to the arrival of Information Mapping's method it was frustrating and challenging to specify patterns in a way that one writer or editor can communicate precisely with another about exactly which chunks of information go in exactly what order in the final presentation of the material. Unfortunately, most often they relied on the idea of making the sequence "logical, " without specifying just what "logical" meant. The ensuing fuzziness has left most discussions of the topic at dead ends. Information Mapping's content analysis brought the powerful capability of a taxonomy and technical vocabulary adequate to the task of specifying a sequence in even the most complex of documents. The method provides basic sequencing templates and facilitates communication in precise ways about sequencing patterns.

Information Mapping from which it takes its name from these formatting innovations. Like geographical terrain information has a topography. It has peaks and valleys, cities and countryside. Like geographical maps, format should relate to this topology on an point-to-point basis. Information maps should guide you through the information just like geographical maps do. The ability to show relationships and guide the user quickly to relevant places are features of the formats and the key to understanding the metaphor of Information Mapping's name.

Section B. Answering Critics

This section of the paper will answer two critics, who have raised a variety of questions about the method. The alleged deficiencies in the method I will address include: (1) the charge that no overarching theory of learning underpins the method, (2) the claim that the method is not truly original, (3) the alleged inability of the method to make certain contributions to teaching, specifically, motivation, explanatory depth, and connectedness among topics, (4) the charge that it is not plausible that you can sort sentences precisely into 40 or so blocks of information reliably at the 80% rate I claim, (5) the seemingly precise yet changing number of blocks used in the methodology, (6) the claimed lack of available research upon which to base guidelines, and (7) the alleged inability of guidelines to do the job demanded of them because of their lack of specificity. As the reader will see, I believe there are sufficient answers to each of these criticisms.

The Charge of No Learning Theory

One critic in England, Alan Fields, has claimed that Information Mapping's method is not based on any solid learning theory or any other kind of theory. Fields says, "Thus, the theoretically oriented educationist can observe two difficulties...(a) the lack of originality of the material in the system; and (b) the lack of an informing theory by which one can measure the effectiveness of the system in producing any results. It can therefore be described as a a theoretical compilation of other people's material." (Fields, 1983) While this criticism has not hindered the progress of the methodology, it should not go unanswered. I have answered the originality question extensively in another recent article, (Horn, 1991 b) so I will not dwell on that topic here.

The answer to Fields' criticism about the alleged lack of theoretical underpinning is that Information Mapping's methodology is based on several theories. Any problem with research is not so much in Information Mapping's

methodology as it is in the state of affairs in learning theory in psychology and educational theory. And what Fields fails to note is that from our first research report, we have claimed that the method was based on research and theory from many fields. (see Horn, et. al. 1969, p. 8-11). This report detailed our reliance on results from the psychological research on the facilitation of learning through the use of highly organized presentation: forms, the structure of subject matters, advance organizers, and critiques of overly optimistic approaches. In that report, we also quoted research or cuing and labeling, pictorial materials and charts, and sentence structure that came from psychological communications, and linguistic research. Further, we cited educational research in concept learning, focus of attention, and the use of active responding, feedback and knowledge of results.

In our second research report, we stated (Horn, et. al., 1971 p.5) That the rules and guidelines for Information Mapping's method had "their origins in such areas as... logical analysis of subject matter, learning research findings, teaching practice, programed instruction techniques, display technology, human factors research, communication techniques, including effective writing principles." Therefore, anyone requiring a single theory as a foundation is certain to be disappointed.

What Fields also fails to appreciate is that rarely if ever can an enterprise with the scope of Information Mapping's method be based on a single theory. This is like asking the design of an automobile to be based on a single theory. Thedesign of automobiles relies on theories of internal combustion engines, much of what we know about electricity, of aerodynamics in its exterior design, air conditioning theory for some of its comfort systems, in some of its details on such things as the chemistry of paints and lubricants, and more recently on all of the theory that goes into making computers, which are now increasingly being incorporated into them. One theory, indeed!

Similarly, Information Mapping's method incorporates user analysis, the analysis of subject matter content, the management of complexity, the sequencing of learning materials, and the formatting and graphic presentation of materials, as well as being closely coupled with the design of training materials of all kinds. In its use in proposals it is aligned as well with theories of presentation of information for persuasion. Each one of these areas requires drawing on research from many fields, as diverse as advertising, media research, human factors engineering, the psychology of learning and the cybernetics of feedback.

Several theories are used, in so far as they and the data which support them are applicable. Moreover Information Mapping is a tool which has multiple purposes. It is used for learning and reference, for communication of technical matter and for persuasion as in business proposals.

Mr. Fields, appropriately classifies himself as a "theoretically oriented educationist." He appears to yearn for a single learning theory that would somehow provide all that was needed for the foundations of a methodology. But some contemporary learning theories can be criticized because they fail to take into account how to devise material for people to use to both during initial learning and in later reference work (because human beings forget at a very rapid rate). Using only one theory (as they are typically developed in learning and educational research) could have serious consequences for a methodology with aims as comprehensive as Information Mapping's.

It is clear from the context of Field's article that he regards Information Mapping's method as a form of "programmed instruction" and merely a "format," both judgments which are incorrect. Rather than a format, it is the method is a life-cycle approach to document analysis, writing, organization, sequencing and presentation. (Horn, 1991b) All critical elements have been incorporated. Its application to literally hundreds of kinds of documents -- from reports and memos to training documents, reference data bases, and on-line help -- surely makes comparison to "programmed

instruction" untenable. Fields appears isolated from the mainstream of even academic research on the method. (see Horn, 1991, for up-to-date abstracts of the major research reports in the field)

Fields also claims that "...because no rigorous informing theory is provided, one cannot judge whether the techniques provided are either necessary or sufficient to enable the student to learn in a near-optimal manner." Here we may come to a simple difference in preference in whether or not some kind of rigorous overarching theory is necessary. In the 60's much innovation was informed by Skinner's behaviorism. It had pretensions of being a comprehensive theory of human behavior. This is not the place to detail the defects of that theory that were presented by the cybernetically oriented systems theorists. These days we have another overarching theory, that of cognitive psychology. What will we have tomorrow? I don't know. The Grand Theories have been of less help than experimental results, careful analysis, and effective synthesis, all of which we use in our approach.

Not Truly Original

Fields has another criticism. He says "It is not easy to say what is 'truly original' about the system." I have fully described my claims for original contributions elsewhere (Horn, 1991,b). Among the innovations I claim are:

• The invention and description of the information block as a new kind of modular approach that permits the use of truly structured writing. The information block has replaced the sentence as the basic unit of analysis and replaced the paragraph as the basic unit of organization and display in much business writing in the U.S. and increasingly around the world.

• The precise specification of different kinds of information blocks amid the specification of different ones of them for different discourse domains.

• The invention of a content analysis approach of question and seven basic information types that clusters different information blocks to guide question asking and to ensure completeness of analysis of the subject matters to be expressed in a document.

• The invention and description of an intermediate unit of structured writing, the information map, that permits easy and natural topic clustering. The map groups one to nine blocks in particular patterns.

• The development of a comprehensive and systematic set of criteria for labeling blocks and maps which permits efficient information management and rapid, effective scanning and retrieval of information from documents.

• The systematic specification of where individual graphics (illustrations and diagrams) should be used and where text would be better.

• The development of easy-to-scan formats that exactly fit with the analysis methodology and categories to aided learning and reference. A wide variety of formats for print and computer screen display have been devised.

• The incorporation of research results from many fields and the creation of an ongoing research program to keep the methodology current.

• The creation of a carefully structured framework that permits the ongoing incorporation and synthesis of good approaches to communication from many different sources.

Fields in particular seems not to recognize the fundamental importance of the information block and the four principles that form it as an important contribution. Yet these are fundamental to understanding the method.

Contributing to Teaching

Fields also takes up the question of the contribution of Information Mapping's method to effective and high quality teaching. He gives the method high marks on three of his criteria, (1) the need to secure and hold the learner's attention, (2) the need for intelligibility, and (3) the need for accuracy and relevance of content.

For another of his criteria, "the need for adequate learner motivation" his is correct in saying "Horn does not have much to say about adequate learner motivation." I have not felt it necessary to speak about motivation in the construction of documentation and instructional materials, because, by an large, I believe that motivation is a result of factors external to the documents. Documents including textbooks make marginal contributions to either initial or continuing motivation. What documents can do is to reduce motivation by being unclear, incomplete, unattractive and hard to use. I grant that the occasional cartoon or humorous example can contribute to enjoyment of reading and, hence, to motivation.

But I can not assign humor and verve of writing a very contribution to the motivation of learning from most scientific, technical, and administrative documents. In the educational classroom, situation the largest factor in the motivation of learning is the teacher-student interaction. The instructional materials have little to offer by comparison.

In two other areas, the need for explanatory depth and the connectedness amongst topics, Fields says that the method does "very little to guarantee these." He then goes on to suggest that this alleged defect in Information Mapping's method arises from its industrial context in which "leads to an assumed requirement just to tell the worker what to do, without elaborate explanatory theories." While there have been such tendencies in industry, recent trends in industrial training are totally contrary to Field's characterization (at least in the United States). Explanation of why a job is to be done and how a process works are regarded as essential to good training methodology. Information Mapping's method has thrived in these circumstances because it is fully capable of providing explanatory depth and connectness among topics. Fields then says, "From the standpoint of academic teaching, however, the lack of connectedness and explanatory depth is a serious defect. Subjects like physics and chemistry require the kind of teaching that shows the interrelationship of key concepts preferably by means of an all-embracing in formatting theory." I could answer these charges in a variety of ways, but perhaps best would be to present counter examples. In particular, a book of essays on philosophy certainly exhibits explanatory depth and connectedness among topics (Horn, 1983). Many other examples that could be cited. Olympia (1979) has written on the use of Information Mapping's method in teaching university-level chemistry and Petrusa, et. al (1985) have described its use in medical education. Twenty-five years of use show that there are few subject matter areas to which the method can not be applied with benefit.

Discomfort of Research Workers

Another English writer, James Hartley (1982) in an otherwise complementary article, listed a series of reasons that some academics are "reluctant" to give the method a try. He suggests that the papers on Information Mapping "suggest too much false precision." He says, "It is not comforting to workers in the field to be told that there are a specific number of blocks which deal with a specific number of types of text."   Yet, neither Hartley nor other researchers have attempted to replicate the amazingly simple research that would convince them of these claims. To show how simple (and inexpensive) such a replication would be, let me sketch the protocol. This is a simple sentence sorting task. In it, your goal is to sort the sentences of a textbook into the categories that have been used in the method since 1965. The further goal is to verify if you can sort 80% or more of the sentences into these categories.   We repeat this experiment is a slightly different form approximately twenty times a month in the classes the company teaches.

Research Protocol

Here is a procedure for replicating the experiments that resulted in the 80% claims.

1. Select a textbook. Separate out the text that is in what we call the domain of relatively stable subject matter. (Horn, 1989)
2. Count the total number of sentences. Call this number T.
3. Teach the analysts who are going to do the taxonomies of Information Mapping's method.
4. Have the analysts sort the sentences from the selected portions of text into the information block categories.
5. Count the number of these sentences. (call this number SASIB for "sentences appropriately sorted by the information block categories."
6. Look at each of the remaining sentences to determine if they are critical to understanding the subject matter or represent sentences that have been added to satisfy the requirements of different rhetorical approaches. Count these that are not critical. (call this number NC)
7. Calculate: T minus NC and call the result "CBNIM" for "critical but not sorted by information block taxonomies."
8. Divide CBNIM by SASIB to give you the percent of sentences critical to the subject matter that can be sorted by the information block taxonomy. If this number is anywhere around 80% of the total then we have not suggested too much false precision.

Number of Blocks Change

Hartley further says, "Nor is it comforting to find, if one looks into it, that these seemingly precise numbers have changed over time--for this contradicts the implied precision." Hartley doesn't give references for the different sources for this statement but I imagine that he has failed to appreciate that we have worked on several domains of discourse over the years. The initial number of around 40 blocks into which approx. 80% of the subject matter of "relatively stable subject matter domains" could be sorted was our first result. (Horn, et.al., 1969) This is the domain of the textbook, the training manual and most reference documentation. Subsequently, I started applying the information block creation criteria to other domains, with most spectacular practicality to business reports, memos and proposals and more recently to user documentation.

After the first success of this research, we began to use the number of approximately 200 for the number of information blocks that we thought were critical to a cluster of several domains and document types. We also proposed information block taxonomies recently for the domains of argumentation and scientific research papers and abstracts. (Horn, 1989)

I should mention that I don't think we have achieved the precision of some other fields such as chemistry, in isolating the elements and molecules of thinking and analysis. But I think that we have achieved great strides toward that goal. And I believe that the approx. 40 information block types and their linkage with the seven information types will stand the test of time. There is, however, certainly room for further research to establish even greater precision.

How Much Available Research?

Hartley also notes that the Information Mapping method "claims to be based on available research. However, as researchers all know, there is really very little research which is directly applicable to designing text, and what research there is often weak, or insufficient to answer all the questions that it raises." I would agree with Hartley that there is less research than we would like. That is a result of the amount of funding devoted to research in this field and partially to the choices of graduate students and their committees as to what they choose to take as a research topic. Surely the amount of science upon which we base our decisions is less than, say, medical science, where laboratories and funding is available to quickly replicate the most important findings, and as a result the researcher can often cite dozens of papers to support one point. But the lack of this kind of massive research program does not mean that we have nothing, nor that we are in as bad a position as Hartley declares.

Let us look at some of what is available in the way of research in only a few of the fields upon which Information Mapping has relied for its methodology. Consider for example, the 944 guidelines each backed by at least one study cited in Smith's and Mosier's (1986) Guidelines for Designing User Interface Software., a book which is 478 pages long and consists of brief statements of guidelines and supporting research citations. Many of these studies, particularly those in the data display section, are relevant to corresponding aspects of the Information Mapping process.

Fleming's and Levie's book, Instructional Message Design, (1978) is another approach at summarizing the specific guidelines and the research supporting them. There are other portions of the research base that are quite deep. For example, concepts are one of the major information types specified for the domain of relative stable subject matter, in the information Mapping method of outlining domains of information. Merrill's and Tennyson's book Teaching Concepts: An Instructional Design Guide, (1977) cites a host of specific studies on learning concepts. This approach has been used in devising the rules and guidelines for Information Mapping's method when it comes to dealing with concepts.

Hartley, however, sums of his part of his argument by saying, "Frankly, I'm amazed at what Horn has achieved by interpreting the available research. I suspect that this achievement points to Horn's success as a skillful practitioner rather than point to the practical value of the research." As complementary as this passage may be to me, I must beg to differ. I actually did find the research useful in developing Information Mapping's methodology and I continue to find it valuable in guiding enhancements including the research of Hartley and his colleagues. But there is no question that in the absence of adequate research, we have to make informed judgments.

Capabilities of Guidelines

Hartley has another observation: "Many research workers are critical of the notion...that one can provide a set of procedures -- or guidelines -- which will be uniformly applicable." He notes that Waller (1980) points out that guidelines oversimplify. Says Waller, "Complex information can only be made to appear easy and approachable by overlooking the exceptions and the special cases." But this criticism fails to note another subtlety of Information Mapping's approach. That is that guidelines and rules can be made very specific and hence quite useful because of the taxonomy of blocks and maps that are an essential part of Information Mapping's approach. It is true, and here I would agree with Hartley, that a very general rule or guideline is almost useless. This is because the rule has to cover so many different situations and so many exceptions that it ends up saying almost nothing.

This is not so with the rules and guidelines of Information mapping's method. We can specify the domain over which the rule or guideline is to govern. This permits the rule/guideline to be very specific. This leads to the kinds of quality control that we have claimed for the subassemblies of Information mapping's method. (see Horn, 1989, p. 114 for a more detailed explanation of this advantage of specifying the domain over which the rule applies) Because Hartley has an admitted suspicion of the ability of the Information Mapping content analysis taxonomies to sort sentences precisely into blocks, it would be logical for him to overlook the possibilities of applying the available research within quite specific ranges of applicability. And perhaps because he is such a careful basic researcher, he shrinks from making the judgments of an applied systems builder must make.

The ability of over 40,000 graduates to apply the guidelines with great precision and quality control is surely data that must confound researchers who doubt the abilities of guidelines to perform adequately.

Hartley is primarily a researcher in the field of learning of text. As I have pointed out above, the analogy of the designer of automobiles must use theory from many different fields. We have borrowed as much research as possible from many different fields, fields as far afield as advertising and human factors engineering, as well as learning research. And like the designers of automobiles, we have used rules of thumb based on the knowledge of skilled craftsmen of the field that as yet are not fully confirmed by research. But that is not so much of a problem because as is well know, research and theory often lags behind practice. The Romans were able to build magnificent bridges, towering aqueducts and the marvelous coliseum without having access to the mathematics that explains why they don't fall down, mathematics which wasn't invented until almost 1,800 years later.

Hartley, does however indicate his approval of the use of guidelines in Information Mapping's method by citing his own work in developing guidelines (Hartley, 1981) And he quotes me accurately as saying "Guidelines are helpful if they are treated as guidelines and not as inflexible rules of procedure."

Summary

Information Mapping's method has stood the test of time and research. (see Horn, 1991a for a summary). And, by and large, it has been treated fairly by the academic community. Hartley and Fields themselves generally give Information Mapping a deep appraisal and for that are appreciated for their contributions in the field. Almost 20 doctoral level dissertations have been completed or are currently in process examining various aspects of the methodology. This fact speaks for itself, demonstrating the ability of the method to generate further fruitful research.

Notes

1. The reader may be puzzled by Alan Fields' article which notes that Information Mapping's method was ten years old in 1981 and the statement of its age as 25 in the title to this article. The 25 year figure is based on the fact that I developed the basics of the method in 1965. All I can say for Fields dating is that he must have dated the method from our second research report. The method dates back to 1965 when I was a researcher at Columbia Universisty's Institute for Educational Technology. The earliest publication is Horn, 1969.

2. The STOP (Sequential Thematic Organization of Proposals) developed at the Hugher Aircraft Company in the late 1950's had a formatting style that required the text to be divided into no more than 500 word units with a fixed format for all of the two-page spreads, text on the left, and graphics on the right.

3. The Information types were completed in 1965, first published as a schema in Horn (1966); incorporated into a research proposal in 1967 and first published in a report in Horn, et. al. 1969.

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STRUCTURED WRITING AT TWENTY-FIVE

by Robert E. Horn

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Abstract

This article is a historical and theoretical summary of structured writing. The approach describes the major innnovations of the approach including: (1) the invention and description of the information block as a new kind of modular approach to writing, (2) the precise specification of different kinds of information blocks for specific purposes, (3) the invention of a content analysis approach of seven major information types that cluster different information blocks to guide question asking and ensure completeness analysis, (4) the invention and description of an intermediate organizational unit of writing, the information map, that permits easy and natural topic clustering vital to efficient retrieval of information, (5) the development of a comprehensive and systematic set of criteria for labeling blocks and maps, (6) the systematic specification of where graphics should be used and where text would be better, (7) the development of easy-to-scan formats that exactly fit with the analysis methodology and categories to aided learning and reference. Each of these topics are developed by the originator of structured writing with an aim toward emphasizing their specific contribution to a comprehensive performance-based approach to structured writing.

STRUCTURED WRITING AT TWENTY-FIVE

Introduction

The problems of today's instructional developers and business writers are considerable. They have to prepare training manuals that enable managers, sales people, office personnel, and technicians to learn new products, services, and operating procedures rapidly and precisely. They have to describe complex, technical and administrative subject matters to a huge variety of audiences. In newer challenges they have to provide online, just-in-time documentation and training to millions working at their personal computers. Proposals, reports, and memos

must be prepared rapidly, clearly, and concisely to meet the high performance communication needs of business today. Structured writing was developed to meet these challenges.

Twenty-five years have passed since the structured approach to writing was first conceived. (Note 1) Perhaps it is a good time to examine just what it has brought into being, to review its claims for novelty, and appraise its accomplishments.

This paper is divided into two parts: (A) an introduction to the principal components of the method and, (B) a section that surveys the major innovations in the method that represent historical "firsts" and their implications for the analysis, writing and presentation of text.

Section A. The Three Major Parts of the Approach

Initially, the structured writing approach grew out of a research program focused on the broad question: How can we make learning easier and quicker for people in complex information rich environments? As this question was examined from a number of different angles, my research began to focus on the a three part approach of (1) content analysis, (2) project life-cycle synthesis and integration of the content analysis, and (3) sequencing and format.

Content Analysis The content analysis side of the methodology initially focused on devising a taxonomy and criteria for a new set of the smallest practical unit of meaning for writing documents in the domain of relatively stable subject matter. This work differed from the approaches to modularity taken by others in that it focused on a deep understanding of the basic units of the subject matter. It depended for its success on the ability to teach others easily and with great uniformity to sort sentences and diagrams of a subject matter into an easily understood taxonomy. (Horn 1992) This was facilitated by the discovery of an underlying structure of subject matter called the information types that clustered a unique prescription for chunking information, called "information blocks" into seven information categories. There is something fundamental about this taxonomy. It has proved capable of first-pass sorting of 80 percent or more of the content of virtually every subject matter that it has been applied to. Thus, the method can be said to capture and sort the "core" sentences of the subject matter. It clusters them into meaningful units for further refinement in the writing phase of documentation and training materials.

Life-Cycle Integration and Synthesis

Eventually, the content analysis was integrated with various planning approaches into a life cycle methodology for writing projects, particularly for projects that were complex and lengthy. It was refined to incorporate efficient recursive procedures for ensuring, in so far as humanly possible, that all relevant subject matter sentences would be gathered from the subject matter expert by the analyst or writer. The life-cycle integration and synthesis is important because the approach has been modified and extended to handle document writing projects at every level of detail and size from the office memo to the

largest and most complex documentation projects encountered by industry and academia. The life-cycle begins with an initial definition of need through definition of the audience to management of the information gathering, to sequencing and final choices of presentation media and format.

Getting the content analysis complete and chunked properly early in the initial analysis phase has enormous benefits all along the way in the life-cycle. In particular, it helps specify what information is missing at any given time in the process. Knowing what you don't know is an important advantage. Therefore, the information gathering phase is greatly simplified. Because the content analysis categories correspond to the deep structure of the subject matter, a systematic way of labeling the content is possible.

Sequencing and Formatting

The third broad area of innovation in the method has been the ability to specify sequencing precisely and the ability to devise very effective formats for presentation of information complementary to the content analysis system.

In the history of writing, especially in training and documentation, there has been a considerable fuzziness in discussions of sequencing. Thus communication among practitioners has been ambiguous at best. The sequencing challenge has always been to specify patterns in a way that one writer or editor can communicate precisely with another about exactly which chunks of information go in exactly what order in the final presentation of the material. Unfortunately, most often they relied on the idea of making the sequence of parts "logical," without specifying and thus we must assume, without knowing, just what "logical" meant and without being precise about the specification of the parts. The content analysis brought the powerful capability of a taxonomy and technical vocabulary adequate to the task of specifying a sequence in even the most complex of documents. The approach provides basic sequencing templates and facilitates communication in precise ways about sequencing patterns.

I will deal with each of these three topics (content analysis, life cycle integration and sequencing and formatting) in more detail in the next section as I explore the contribution of different parts of Information Mapping's method.

Section B. Innovations Incorporated in the Method

As this paper is a summary of the structured writing and its progress, it is a good place to survey in retrospect the specific advances made and to begin to assess their effects. In this section I will first examine the various innovations that represent historical "firsts" and then examine the impact of putting them all together.

1. Precision Modularity of Information Blocks

Modularity is a major concept in engineering. It has been thoroughly incorporated into software engineering as subroutines. This concept

certainly influenced my work on developing information blocks. There were precursors to the structured writing concept of modularity into technical and business writing. (Note 2) But, beginning in 1967, structured writing can claim to be the first to to define and develop a precise modular concept ("information blocks") that are firmly grounded in a taxonomy of information types. (Note 3) Let us examine both the concept of modularity and then the concept of information types.

Horn, et. al. 1969 were the first to specify a finite group of 40 information blocks that claimed to covered 80% of a given domain of discourse. The initial discourse described was that of relatively stable subject matter (Horn,1989). It will be useful for the reader who is unfamiliar with the method for me to unpack the above sentences to give some depth of understanding to the concept of a finite group of precisely specified block types.

What are blocks? Information blocks are the basic units of subject matter in structured writing analysis. They replace the paragraph as the fundamental unit of analysis and of presentation. They are composed of one or more sentences and/or diagrams about a limited topic. They usually have not more than nine sentences. They are always identified clearly by a label. Information blocks are normally part of a larger structure of organization called an information map which can be defined as a collection of one to nine blocks all related to a specific topic. In short, they are a reader-focused unit of basic or core parts of a subject matter.

Among the many constraints on the writing of blocks are four principles: (1) The chunking principle (which says, "group all information into small manageable units"); (2) The relevance principle (which says "include in one chunk only information that relates to one main point based on that information's purpose or function for the reader"); (3) The consistency principle (which says "for similar subject matters, use similar words, labels, formats, organizations and sequences"); and (4) The labeling principle (which says "label every chunk and group of chunks according to specific criteria"). These principles along with a variety of specific guidelines and rules give blocks the property of considerable precision. The initial kinds of blocks for relatively stable subject matters are shown in Table 1.
What is the importance precision modularity? It accomplishes a number of purposes. First it enables the analyst/writer to manage information by guiding systematic questioning of subject matter expert. When combined with the information types analysis (see below), it enables writer/analyst to do completeness analysis (i.e. to determine within, the bounds of possibility of today's level of technology, exactly when the analysis is complete and all information needed for the document has been gathered). When applied properly, it refines the basic idea of modularity to a place where each chunk of information can be considered a true subassembly for documentation engineering. Further, such precision enables the manager of documentation to specify guidelines and rules that apply only to certain types of blocks rather than to more fuzzily defined units, permitting the kind of efficiency, reliability and effectiveness that such standardization usually provides. Precision modularity provides the solid basis for assisting the analyst/writer in

organization/sequencing phase later on. And it enables computer-based training and reference systems to be built on precision modularity.

2. Analysis Categories of Information Types

Another historical first credited to structured writing was the definition and development of a set of content analysis categories and question types based on the (now) seven (then, six) information types. (Horn, 1966; See Horn, 1989 for a more extensive explanation than given here)

The seven information types are:
% Procedure
% Process
% Concept
% Structure
% Classification
% Principle
% Fact

This is a key set of categories for specifying and describing how human beings think about relatively stable discourse domains (Horn, 1989). Guidelines permit the information blocks to be assigned to information types and thus it permits the identification of what has come to be called "key specific block" information, that which one must have, to fully understand specific topic. Key blocks, by themselves, do not give one all of the information needed for a piece of writing but they enable writers to anchor their writing firmly and reliably to the centrally important structure of a subject matter, and, thus, aid in the process of specifying the subject matter.

What is the importance of the information types? The information type taxonomy enables the analyst/writer to more easily specify the subject matter and contributes to achieving completeness of analysis. Being able to identify the information type of the topic under analysts further enables the analyst/writer to formulate questions for subject matter experts that bring information gathering phase toward completeness and comprehensiveness. It further enables the analyst/writer to formulate specific more appropriate and systematic labels that will aid readers in scanning and learning.

3. Information Management Through Information Maps

An unending sequence of structured information blocks would fail to provide readers with natural and logical ways to cluster important concepts, procedures, processes, etc. It would be little better than an endless sequence of gray paragraphs one after another. It would hinder rather than aid searching for retrieval. To solve this problem, the method was also the first to develop and incorporate the concept of the information map, as a collection of one to nine information blocks.

The information map provides an important intermediate level of specification of document organization. It enabled the clustering of blocks all related to a topic (and where possible an information type) together and to suggest an appropriate labeling system for them. (see

below for further discussion of labeling) It was also first to link the idea of the information map with the seven information types. (Horn et. al., 1969)

What is the importance of the information map? The information map enables the user/learner to receive all information connected with a particular topic together. This facilitates the organization of the document. The information map enables the analyst writer to specify and know what information is present and what is absent at the level of individual concepts, procedures, etc.

4. Systematic Criteria for Labeling Modules

Another structured writing innovation first was the recognition that a criteria and method of specifying the headings and subheadings was needed for a true technology of structured writing. It goes without saying that we did not invent labeling. But, structured writing was, the first to specify a systematic criteria for headings and subheadings (called, in the methodology, "block labels" and "map titles"). It specified the criteria for labels for specific information types, maps, and blocks. It specified the criteria important for learning use, reference use and for mid-project information management. (Horn, et. al., 1969; see also Horn, 1989) Incorporated in this approach was a three-fold approach to creating labels: (1) those labels which described the specific content of the subject matter, (2) those labels that described the functions which the block or map performed that were similar across subject matters (e.g. definition, example), and (3) those labels that were combinations of these two types. Each of these types were carefully studied and guidelines for effective use have been prepared.

What is the importance of this part of systematic labeling? With systematic labeling comes great efficiencies in managing and rearranging the information for different users. Also based on the validity and appropriateness of the content analysis, the method has the ability to specify rules and guidelines at the appropriate level of detail that make them extremely sharp and useful to the writer . This contrasts with the usual experience of writing guidelines which are typically either too detailed or too general and vague to be really useful. The information block and information map levels as well as their division into types, gives a powerful way to divide writing guidelines. The life-cycle efficiencies also accrue because of the common language that the content analysis gives to users of the method. This common language permits intensive and efficient work in teams.

In summary, the importance of the labeling technology is that it: % enables readers to scan content to and quickly understand the structure of the documentation and the subject matter % enables readers/learners to to find what they are looking for in a consistent, relevant, complete manner; % enables to analyst/writer to manage the intermediate stages of information gathering and analysis in a more efficient way; % enables learners to anticipate learning problems by showing its structure to them.

5. Systematic Specification of Graphics

Structured writing respects the importance of visual communication in today's complex world. Among its firsts was the specification, as a normal part of analysis and writing, of exactly where (i.e. in precisely which information blocks) graphic formats, diagrams and illustrations should be preferred over text. (Horn, et. al. 1969; see also Horn, 1989 for examples of the use of graphics fully integrated with text.)

In so far as we know, this was the first, as a part of a system, to require that the graphic or illustration always be located within the text where the reader needs it, rather than at some other location as is done in most documents (where the illustration may be located on facing page, next page, or some other place in of the document, but not where it is referred to in the text). It further specifies that information put in the caption of the illustration should often actually be incorporated into the illustration itself so that the reader's eye does not have to search to identify verbal meaning associated with the visual element. It is significant to note that these were all specifications of routine use of the method, not occasional guidelines.

What is the importance of systematic specifications of graphics? The importance of this integration of graphics and words permitted the specification in a precise manner the question "Exactly when and where is a picture worth a thousand words?" It further enabled readers to more swiftly scan and use documents, because they did not have to search all over the document for illustrations and diagrams and their explanations. It also ensured that content that should be explained with visuals were done that way.

6. Systematic Specification of Formats

In addition to the specification of graphics that appear in the text, the structured writing from its inception, paid attention to the formatting of content. This was important because it was recognized from the start that readers needed help in coping with the immense amount of information they had to process every day. It was recognized that much of this information processing in everyday situations of business, science, and technology involved the scanning of documents to find exactly the parts that were important while skipping the rest. And it was recognized that innovations were needed to provide the type of formats that would aid such scanning. Since then, a large variety of formats have been developed to suite different needs of different document types. These formats help the writer get the document ready for print media as well as display on computer screens.

While the formats were initially developed to aid the reference and rapid scanning modes of use, these same formats also aid learners in pre-organizing and sizing up their learning tasks. They also convey the organizing of the subject matter and the organization of the document to the learner.

One format, used early in structured writing development, was the now

familiar use of a title at the top of every page (which is the title of the map) and labels for each information block in the left margin. The title at the top functioned to orient the reader at all times and to show the chunking. The marginal labels were borrowed from 18th and 19th century printers who sometimes used them in textbooks. But a large number of improvements were made in this idea, including the exact specification of labels size, and type of use, as well as the combining of them with map titles to form a kind of grid that kept the reader oriented while they dip into the document at any place. The formats are also the most visible aspect of mapped documents. People immediately recognize how easy it is to scan and skip to what they want to read. They recognized the rapid access that the formats provide on every page. They begin to have confidence in the document and in their ability to understand what it contains.

Over the past 25 years, this format has caught the attention of many graphic designers and document publishers in industry. And unfortunately they have often borrowed the formats without the structured writing requirements of the analysis phase thus providing for readers only a superficial rendering of the approach by using only its formats.

This lack of analysis has sometimes reflected negatively upon structured writing in two ways. First, such unanalyzed documents do not provide readers with the information that they need (because no other approach provides as much guarantee of completeness of analysis). Second, the lack of analysis has also reflected negatively upon the method because many people have come to think of the method have thought of is as "only a format."

However, there is a large and growing group of writers (that numbers over 150,000 world wide) that recognize the critical distinctions that warrants the name of "true" structured writing.

8. Life Cycle Methodology

Documents in business, industry, science, and technology have a life of their own. They go through many drafts, often being looked at and approved by many levels and parts of an organization. Then, after publication, they are revised and kept in place, sometimes for many years, even decades. This requires the document manager to have in place a methodology that enables quick and easy revision of the document, for document managers know that maintenance can be one of the most costly aspects to document management.

Here again, the structured writing was the first to present a comprehensive technical writing methodology that covered the document life cycle. It was the first to show that the precision modularity of information blocks and information maps affected the entire life cycle from (A) initial project specification and learner/user analysis to (B) information gathering and analysis to (C) management and organization of the growing subject matter content database in large projects (D) to the sequencing and final formatting and display of documents on screen or paper. (Horn, et. al. 1969) And after full implementation it was the first to show how easy document maintenance could be, no matter how complex the subject matter. (See Horn, 1989)

Previous writing styles are a lot more intricately interwoven. Themes and paragraphs are are written to please the more literary taste. Documentation managers continue to face many maintenance problems if they chose such old, non-structured writing approaches.

What is the importance of life cycle methodology? The life-cycle concept is the most efficient method of document development. It increases the chances of gathering all of the information needed early in the project and reduces rewriting to a minimum; it also helps specify at any given point what is not known about the content. Finally, it provides efficiencies in costly document revision cycles, no matter when they occur.

9. Synthesis and Integration of All Important Components Document Development

A good deal of the success of structured writing is that it gives attention to all of the critical aspects of document development and integrates these with the novel methodological components described above. While there is much innovation that sets structured writing apart, we have never claimed that everything in structured writing is novel or unique to it. It incorporates many concepts and techniques invented by others. (Horn 1992a) Notable among these borrowings are the incorporation of the critical elements of performance technology, the use of job aids, the incorporation of ordinary language algorithms (Lewis,1967) and decision tables. What has been unique about these borrowings, has been the ability of the overall structure of structured writing's taxonomies, life cycle procedures, and guidelines to specify exactly where these other techniques are needed and to incorporate them seamlessly into the final presentation.

An additional advantage is that structured writing incorporates many of the tools from performance support technology while presenting itself as an analysis and writing methodology. And it does this with the minimum of technical terminology from the performance and training field so that writers who encounter it are not encumbered by gigantic amounts of jargon. The synthesis it provides, has resulted many large improvements in effectiveness and efficiency, as we shall elaborate on below.

10. Specify Requirements for Just-in-Time Learning and Reference

Before the introduction of structured writing, it was rare to find practitioners distinguishing clearly between initial learning and reference for the specification of what users required. Mager (1975) had pioneered in the specification of learning objectives, and Lewis (1967) had shown the usefulness of ordinary language algorithms for job aid and reference use. But few researchers or practitioners had paid attention to the fact that most people forgot most of what they learned within a few weeks of learning it. Few called attention to the different requirements that the world of business technology was growing so complex and was changing information faster than we could learn it. Few thought then that this situation called for a

completely different approach to the analysis and presentation of many kinds of learning documents. In fact, twenty-five years ago, there was puzzlement when I first began to say that what was needed now was a whole new information environment in which human beings could learn things as they needed it, rather than preparing themselves to know everything they needed to know before taking on a job.

In structured writing there is a requirement to specify in the first phase, exactly what is required of the documents. The first distinction was to call attention to (and to precisely specify) requirements for the dual functions of initial learning and reference. Then specialized applications of these approaches were designed specially for combining or dividing the two functions. (Horn, et. al.. 1969; 1971) They can be kept separate in such initial learning methodologies as in pure fluency training (Binder, 1990), or in pure reference such as some kinds of user documentation. The two functions of initial learning and reference can be combined as in reference-based training (Ross, 1987; Horn, 1989, p. 118) which is a term for just-in-time training. The early concern for this has helped shape the specific applications for the material and has led to the more recent specification of discourse domains (Horn, 1989, p. 104) which help the writer keep clear that quite different purposes and interaction produce quite different analyses and presentations.

What is the importance of carefully analyzing learning and reference? The importance of making clear distinctions among purposes and following them with the kind of structured analysis described above enables analyst/writer to make precise determinations of sequencing of documents for different learning and reference situations. It also enables analyst/writer to analyze precisely prerequisite and classificatory relationships of information blocks. This in turn provides clear criteria as to what to include in a particular document.

11. Experimental Research Program for Rhetoric

There has been an ongoing research program, instructional writing, since 1965. Prior to it, there was little, if any experimental work, done in the area of rhetoric. But one of the most unique aspects of our early research was to insist upon using research that had been done in various fields, such as psychology, education, advertising, human factors engineering and cybernetics. In so doing, it became an important force in shaping the field of rhetoric, which for centuries has been more closely aligned with the study of persuasive communication, the composition of literary art, legal reasoning, and coaching for better speech-making.

Three aspects in particular have contributed to this new approach to the study of rhetoric: (1) the continuous attention to keeping structured writing in tune with contemporary research, (2) its continuous focus on providing the utmost in the clarity of communication, and (3) its focus on developing a new units and frameworks for precisely structuring communication.

What is the importance of continuous updated research base? The focus on research based methodology for analysis and writing moved writing

methodology into realm of learning and retrieval experiments so that research and social science methods could be used to investigate rhetorical variables associated with a comprehensive methodology. (See Horn, 1992c, in press) It further enabled practitioners to use believably such new metaphors as "documentation engineering" for what they were doing. (Horn, 1986) This firm foundation in research and practice is a strong base for future development.

Summary

To summarize, perhaps it would be appropriate to list the range of novel techniques, approaches, and syntheses that have been integrated into structured writing. In this article, we have pointed out these innovations:

% The invention and description of the information block as a new kind of modular approach that permits the use of truly structured writing.

% The precise specification of different kinds of information blocks for specific purposes

% The invention of a content analysis approach of question and information types that clusters different information blocks to guide question asking and ensure completeness analysis

% The invention and description of an intermediate unit of structured writing, the information map, that permits easy and natural topic clustering

% The development of a comprehensive and systematic set of criteria for labeling blocks and maps

% The systematic specification of where graphics should be used and where text would be better

% They development of easy-to-scan formats that exactly fit with the analysis methodology and categories to aided learning and reference

% The incorporation of research results from many fields and the creation of an ongoing research program to keep the methodology current

% The creation of a structured framework that would permit the incorporation and synthesis of good approaches to communication from many different sources.

Notes

1. The structured writing approach dates back to 1965 when I was a researcher at Columbia University's Institute for Educational Technology. The earliest publication is Horn, et. al., 1969. Most of the literature on structured writing refers to it by a trademarked name "Information Mapping" which is a registered trademark of Information Mapping, Inc. 300 Third Ave., Waltham, MA. 02154. However the generic term for the approach, which I suggested in the

early 1980's is "structured writing". Often authors of "structured writing" documents use different and more loose standards for analysis, organization and display of information than those who practice Information Mapping's method. The characteristics described in this article refer to those which I first synthesized into Information Mapping's method. Since the name "Information Mapping" is trademarked, we must abide by the requirements of the trademark law and mention that fact.

2. The STOP (Sequential Thematic Organization of Proposals) developed at the Hughes Aircraft Company in the late 1950's had a formatting style that required the text to be divided into no more than 500 word units with a fixed format for all of the two-page spreads, text on the left, and graphics on the right.

3. The information types were completed in 1965; first published as a schema in Horn (1966); incorporated into a research proposal in 1967 and first published in Horn, et. at. 1969.

4. The formatting innovations are that aspect from which it takes its name. Information has a topography like geographical terrain. Information has peaks and valleys, cities and countryside, and roads and superhighways that connect them. Like geographical maps, formats should relate to this topology on an point-to-point basis, in so far as possible. Information maps should guide you through the information just like a geographical map do. The ability to show relationships and guide the user quickly to relevant places are features of the formats, and the key to the metaphor of Information Mapping's name.

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Table 1.
Most Frequently UsedBlock Types
(in domain of relatively stable subject matter)

Analogy
Block Diagram
Checklist
Classification List
Classification Table

Classification Tree
Comment
Cycle Chart
Decision Table
Definition

Notation
Objectives
Outlines
Parts-Function Table
Parts Table

Prerequisites to Course
Principle
Procedure Table
Purpose

Rule

Specified Action Table
Stage Table
Synonym
Theorem
When to Use

WHIF Chart
Who Does What
Worksheet

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Second Research Report

to the U.S. Airforce

1971

DOCUMENT RESUME

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IDENTIFIERS	*Information Mapping	

ABSTRACT

A new conception of computer-based instructional systems is presented in this design of a system that can deliver individualized information sequences not only to learners and trainees, but to reference workers, reviewers, etc. Underlying the system is a flexible data base organized into labelled, movable information blocks according to the principles of "information mapping"-- a system for categorizing and displaying information. This report itself is written in modified information-mapping style. A significant feature of this computerized information service is that the control of information selection and arrangement can be assigned entirely to the user, entirely to the system, or to both in one of the many possible patterns of shared responsibility. When the system takes part in information-sequencing decisions, its many mechanisms for individualizing come into play. The executive program consults short-term and long-term data about the individual, his objectives, capabilities, interests, and present status before it selects and arranges blocks from the data base to display for him. Evaluation and feedback are also individualized. The system's capability for controlling conditions and recording user-system interactions make it suitable for research on individualization in education. (Author)

ESD-TR-71-165

INFORMATION MAPPING FOR COMPUTER-BASED LEARNING AND REFERENCE

Robert E. Horn
Elizabeth H. Nicol
Richard A. Roman, et al

March 1971

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FOREWORD

This research was conducted under Project 2801, Information System Design Methodology; Task 280104, Computer-Aided Instruction Techniques. The objective of this task is to develop design principles and specifications for automated systems which support training and performance-aiding. Such systems can be built into Air Force computer-based information systems and used in a time-sharing mode for on-site training and performance-aiding of system personnel; or they can be used in Air Force resident schools for training the student population.

This report is one in a series supporting Task 280104. It is the second of two reports on a systematized technique for formatting and sequencing training and performance-aiding information. The study was aimed primarily at a specification methodology for dynamic information displays sequenced by a computer. The principles involved are also applicable to conventional hard copy information display, e.g., military manuals.

This design study was carried out between November 1969 and February 1971 under Contract No. F19628-70-C-0103 with Information Resources, Inc. Cambridge, Massachusetts. Project staff members and their areas of responsibility were: Robert E. Horn, who directed the project and undertook documentation and classification functions; Richard A. Roman, who was primarily responsible for the design of the executive control program (the sequence generator) and the command language; Elizabeth H. Nicol, general project consultant, who was engaged in planning, analysis, and evaluative functions and who wrote the final report; Margaret P. Razar, who served as project coordinator and who wrote extensive system documentation.

The Air Force Task Scientist and Contract Monitor was Sylvia R. Mayer.

Publication of this report does not constitute Air Force approval of the report's findings or conclusions. It is published for the exchange of information and stimulation of ideas.

Sylvia R Mayer

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4

ABSTRACT

A new conception of computer-based instructional systems is presented in this design of a system that can deliver individualized information sequences not only to learners and trainees, but to reference workers, reviewers, browsers and the like. Underlying the system is a flexible data base, organized into labelled, movable information blocks according to the principles of Information Mapping--a system for categorizing and displaying information. This report is itself written in modified Information-Mapping style. A significant feature of this computerized information service is that the control over information selection and arrangement can be assigned entirely to the user, entirely to the system, or to both in one of many possible patterns of shared responsibility. When the system takes part in information-sequencing decisions, its many mechanisms for individualizing come into play. The executive program consults short-term and long-term data about the individual, his objectives, capabilities, interests and present status before it selects and arranges blocks from the data base to display for him. Evaluation and feedback provisions are also individualized. The system's capability for controlling conditions and recording user-system interactions will make it a valuable force in research on individualization in training and education. The development of this complex design was facilitated by a Documentation-Updating System that produced system documents in Information-Mapped form and kept them up to date throughout the project.

TABLE OF CONTENTS

CHAPTER 1 INTRODUCTION TO THE PROJECT

OVERVIEW OF THIS DOCUMENT

Introduction

This document describes the design of a computer-controlled information system whose specially organized data base serves a variety of users' purposes: initial learning, reference, reviewing, browsing, and briefing.

The data base consists of information segments organized according to Information Mapping, a system of rules and policies for classifying and formatting information into separate labelled modules. These information blocks can be drawn from the data base, arranged and displayed in a form best suited to the purposes of the individual client.

This document describes how the system design accomplishes the objective of delivering information sequences to the individual taking into account his capabilities and previous experience.

The First Chapter

An information system that is to serve multiple purposes from a common information base must rely on a variety of concepts and procedures to accomplish its functions. This first chapter will introduce the main features of the system.

The Second Chapter

Information Mapping is one of the key concepts in this system design. Here we tell what it is, how it developed from research results, educational practice, graphics, and so on. Its application to computer data bases requires some new procedures, which are outlined here.

The Central Chapters

The mechanisms and procedures that were designed to select and deliver appropriate information sequences are described in the next three chapters. How the system makes an individualized response to members of each user class is explained here and illustrated with fictitious case histories.

Documentation-Updating System

The data and information being developed about the Learning-Reference System were documented from the beginning and were maintained in an updated state throughout the project. The methods for producing documents in Information Mapped form and the explicit updating procedures are described.

The Last Chapters

The final chapters summarize the description of the total system, some ways of evaluating it, and some future applications.

THE CONTEXT OF THE NEW SYSTEM

Introduction

When a new development emerges, we are usually curious to know where it fits into the current scene.

The system we are introducing here is a new kind of computer-assisted instruction. It serves reference uses, reviewing, browsing and briefing, too, but it is within the context of computer-aided training and instructional systems that its similarities and differences may best be identified.

Individualized Instruction

Back in the early 1950's, one of the impressive selling points of teaching machines was the fact that they let the individual proceed at his own pace. Through the heyday of teaching machines on into the development of more versatile computer-based systems, the search for new ways of adapting instructional sequences to the individual user has continued.

In spite of undoubted gains, the goal of achieving individualized instruction has been advanced only slowly. The main progress has been in the area of adjusting instruction to short-term information about the user--a wrong answer, for instance, causes him to be shunted off to a corrective sequence, while consecutive correct responses may cause him to by-pass some materials. The long-term history of the user seldom enters into information sequencing decisions.

The system we are reporting is designed with the capability to respond to the individual by basing its sequencing decisions on both permanent and changing information about the user--for example:

- his capabilities, attitudes, interests, objectives
- his academic training and history
- his performance and patterns of behavior within the learning system
- his personal wishes and preferences.

Thus the system has the capability of responding to the long-term as well as short-term history of the user. The extent to which this capability is used depends upon whether the course designer will specify how individual differences are to be served by differences in information sequencing. It also depends upon whether the individual user is guided by the system or controls his own interaction with the information base.

continued on next page

Control of Instructional Conditions

An important difference between this system and others lies in the variations in degrees of control that this system can exercise over the sequencing of information.

In the majority of CAI systems, the path of the learner is almost totally determined by the computer program. In a few other systems, the so-called "ad lib" systems*, it is the user who determines what information is called up from the data base.

Our Learning-Reference System is designed to operate not only under either one of these extremes of total user control or total system control, but also at any one of numerous points in between. In other words, the learner can take charge of all sequencing decisions, he can share some with the system, or he can be totally dependent on the system for information selection and display.

This range of possible controls adds another set of dimensions for individualizing instruction, but, most importantly at this imperfect stage of our knowledge, it allows experimental control of variations in learning conditions so that research may refin the prescriptions that link personal data, information sequences, and learning results.

Such an outcome is realizable because the system has record-keeping advantages that permit study of long-term effects of sequencing strategies.

Later

After the capabilities of this Learning-Reference System have been described in this report, we shall return, in the final chapter, to some of the topics raised here.

* Bryan, G.L. "Current ONR Research Efforts Involving Computerized Instruction," Proc. of the Conference on Applications of Computers to Training (ACT), Washington, D.C., 1970.

THE ORIGINS OF THE PROJECT

Introduction

The idea of designing a computer-controlled system that would serve many users from a common information pool originated in a previous research and development effort to design more effective materials for both learning and reference users.

From that work, Information Mapping emerged as a system of rules for identifying, categorizing and interrelating the information needed for learning-reference purposes.

When applied to any subject matter, Information Mapping yields a network of labelled and classified information blocks. From these blocks, materials in book form can be produced for self-instruction and reference purposes.

It was no large step to conjecture that if a computer data base were organized by Information Mapping rules, it might serve the information needs of a wider range of users. The separate blocks could be drawn from the common pool as needed and then assembled into sequences suitable for initial learning, reference work, browsing, reviewing and the like.

In order to accomplish such a service, the system must be able to evaluate and respond to the needs of the various users and then to deliver information sequences that are appropriate.

Basic Objective of This Project

The objective of this project was to plan a computer information system that selects blocks from an Information-Mapped data base and assembles them into displays of information suited to the needs of the individual user.

The Learning-Reference System

Although we conceive of this system as providing information services to a variety of users, we refer to it as the Learning-Reference System because we expect the main traffic to be from those with initial learning and reference needs. Nevertheless it is also designed to serve those who come for reviewing, briefing or browsing.

The Design Process

The project began with general ideas about the nature of the system; then the characteristics desirable in such a system were formulated in detail. The main work of the project consisted in developing a design for the structures and programs that would make the system a reality.

This report is the description of the system design that evolved.

Comment

Before taking up the process of defining the system, we first say more about Information Mapping itself for it plays a fundamental role in the system.

INFORMATION MAPPING: ITS BACKGROUND

Description

Information Mapping is a set of rules and procedures for writing, organizing and displaying information about a subject matter. According to a unique classification scheme, information is categorized and collected into labelled blocks. The order and format in which these blocks are displayed are geared toward making learning easier and information retrieval more efficient.

The system has been applied to the production of books for learning and reference and now in this project it is applied to the organization of multipurpose data bases for computerized information systems.

Basic Aims

Research and development on Information Mapping have been concerned primarily with these objectives:

- to make learning, reviewing, reference work and browsing easier and quicker than in conventional texts and in computer-aided instruction
- to provide information services responsive to the needs of the individual user
- to make the preparation of learning and reference materials easier and quicker than for conventional materials
- to make the task of maintaining and updating information banks both systematic and economical.

Origins of Information Mapping Features

Initially, research findings, generalizations, and procedures from many areas were considered with a view to their possible practical value for instruction or reference.

Gradually we evolved the set of guidelines and rules for organizing and displaying information that we now refer to as Information Mapping. These guidelines have their origins in such areas as these:

- logical analyses of subject matters
- learning research findings
- teaching practice
- programmed instruction techniques
- display technology
- human factors research
- communications techniques, including effective writing principles.

The implications of the various ideas were translated into practical form and were documented as rules or procedures for preparing Information Maps.

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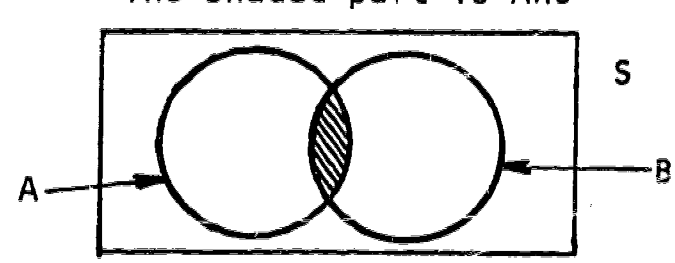
Applications	Information Mapping has been applied to the production of self-instructional books in the areas of probability, statistics, computer programming, and Information Mapping techniques as well. Exploratory work with simulated computer displays and information block assemblies has provided some useful spadework on the kinds of options and display variations that a computerized system could offer to its users (Horn, Nicol, Kleinman, Grace, 1969).
Comment	Because Information Mapping is of central importance in the present project, Chapter 2 will give a more detailed account of how came about and how it is done. However, it may be useful at this point to see the form of a map designed for self instruction. An example is shown on the next two pages; other examples appear in the appendix to this report.

EXAMPLE OF A CONCEPT MAP

THE INTERSECTION OF TWO OR MORE EVENTS IS ALSO AN EVENT *

Introduction	Sometimes we are interested in an outcome that has more than one description - as, for instance, in a car that is yellow, Jaguar, and convertible. Such an outcome would be common to three different events.
Definition	The intersection of two or more events consists of those sample points that are common to the given events. These common sample points in the intersection or "overlap" of the events constitute a new event. The new event is said to occur if an outcome common to the intersecting events occurs.
Notation	The symbol for intersection is $\cap$. $P \cap Q$ is read "the event P intersection Q," or "the event composed of the intersection of events P and Q." The event $P \cap Q$ is said to occur if both events P and Q occur. The general case of the intersection of any number (n) of events can be written: $A_1 \cap A_2 \cap \ldots \cap A_n$
Diagram	The shaded part is $A \cap B$ 
Comment	Outcomes in the "overlap" where events intersect have more than one description since they belong to more than one event; for example, "both red-haired and blue-eyed" is the intersection of two events; "left-handed, a pitcher, and a Yankee" is the intersection of three events; and "tall, dark and handsome but married" is the intersection of four events.

continued on next page

* From Introduction to Probability, Kleinman, Nicol, Grace, Horn, 1971. (In preparation.)

THE INTERSECTION OF TWO OR MORE EVENTS IS ALSO AN EVENT (continued)

Example One

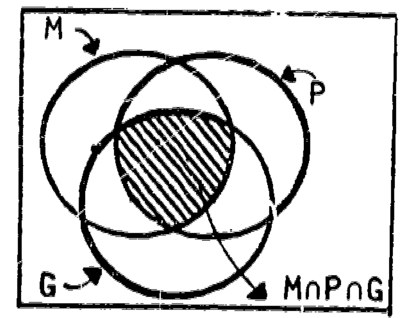
A survey at a college asked each student about his interest in these subjects: mathematics, psychology, government. Those with a strong interest in all three were given another questionnaire about career plans.

Event M = strong interest in mathematics
Event P = strong interest in psychology
Event G = strong interest in government

Then the new event

$M \cap P \cap G$

represents those who received the second questionnaire.



Example Two

An urn contains ten balls numbered one through ten. One ball is drawn.

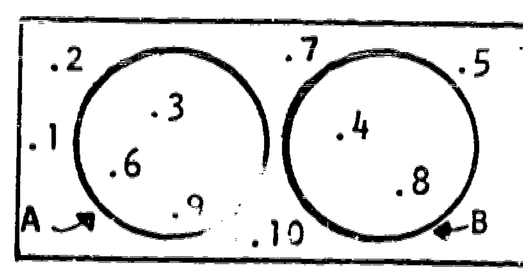
Event A = the ball drawn has a number divisible by three.
Event B = the ball drawn has a number divisible by four.

$A \cap B$ is the new event: "the ball drawn has a number divisible by three and by four."

$A = \{3,6,9\}$

$B = \{4,8\}$

$A \cap B = \phi$



Note: No member of A are in B. $A \cap B$ is the empty event.

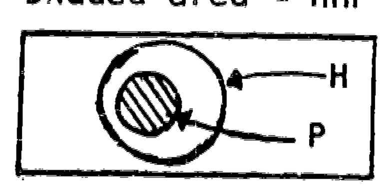
Example Three

If the 52 cards in a bridge pack are the sample space, we can define:

Event H = all heart cards
Event P = all heart picture cards

The event $H \cap P$ is identical with event P since all outcomes in P are also in H.

shaded area = $H \cap P$



Related Pages	outcome, 14 event, 23	sample point, 17

MAJOR TASKS OF THE PROJECT

Introduction	A data base consisting of movable information segments could have the flexibility required for a system that aspired not only to serve various purposes but to serve them in a manner responsive to the individual inquirer. To accomplish the design of such a computer system, we outlined four major task areas and specified the end result we expected from each.
1 Data Base Organization	The rules and formatting policies for writing Information Maps were originally developed for making books for initial learning and reference use. Now to apply them not only to the organization of computer data bases but also to the serving of other client classes means that they will need expansion and adaptation. For example, study of the reviewing and briefing situation may show the need for additional maps to be made available in storage. Also it is clear that the data base must contain not only the information blocks themselves but also all sorts of data <u>about</u> the blocks (name, content, difficulty level, etc.) so that the computer can judge their relevance for a particular user. <u>The end product</u>: The expansion of Information Mapping rules to cover the preparation of information bases for computers and a document of detailed directions for carrying out the necessary procedures.
2 The Sequence Generator	If we think of Information Mapping as a set of rules for partitioning the sentences about a subject matter so that they may be categorized, labelled and stored in the computer, we realize we need a second set of rules to govern the retrieval and arrangement of the information modules for display to the user. This second set of rules we have called the "sequence generator." This will be the executive program that consults various kinds of data about the user and the state of the system before selecting from the information-block bank a series of displays appropriate for the objectives and needs of that user. The design of such a sequence generator was another major task of this project. <u>The end product</u>: The specification of all classes of data required by the sequence generator and a set of decision rules that indicate in detail the course of the sequence generator's functioning in all user-system interactions.

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3	The Command Language	The system must have a language through which the user can communicate his information needs and his reactions to the displays presented to him. <u>The end product</u>: A document defining each term in the set of commands designed for the system and specifying the effects such commands have on the system functions by way of the decision rules of the sequence generator.
4	Documentation-Updating System	The development of so complex a system is achieved through the process of successive approximations. Thus it can be predicted at the outset that not only will there be a heavy demand for documentation by the team of designers who are creating the system but also there will be an urgent need for updating procedures that keep each team member in touch with the latest thinking of his colleagues. This fourth task of the project was to devise and follow systematic procedures for keeping track of the information developed in the course of the project. System documentation is to begin when the design project itself begins. The key idea is to test the utility of Information Mapping as the form in which all system information will be written and stored. We will specify the detailed procedures for preparing system documents and for entering into multiple copies of them the latest available revisions. Procedures developed in the course of this task are expected to be applicable to the maintenance of the Learning-Reference System in the operational stage -- that is, to changing both course materials and system functions throughout the life of the system. In this aspect of the system, we expect the updating procedures to be automated and serviced through routine computer-directed interviews with the updating clerk. <u>The end product</u>: A tested set of procedures for: · preparing system documentation in Information Mapped form · keeping system documentation up-to-date during its evolution · maintaining the system at its highest efficiency during real-time operations.

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Project Document

The end product of the entire project: a document that gives specifications, procedures, decision rules, present limitations and possible future extensions for various aspects of the system.

The objective was to develop the design in sufficient detail so that it is capable of being implemented by programmers who can adapt it for a given computer configuration.

Project Document One presents the system design in a series of separate sections. Because of the extensiveness of the material, not all sections are equally available. The table below shows the main subdivisions of the documentation along with an availability symbol which is explained below:

SECTION	TITLE OR DESCRIPTION	APPROX. NO. OF PAGES	AVAIL-ABILITY
000-599	Detailed plans for a Sequence Generator for use with Information Mapped Data Bases	150	A
600-699	Detailed decision tables for implementing major functions of the Sequence Generator	180	A
700-799	A Reference Collection of Rules and Guidelines for Writing Information Mapped Materials (described in Chap. 2 of this final report)	175	A & B
800	A detailed description of the Information-Mapped Documentation-Updating System (described in Chap. 6 of this final report)	100	A
Index	An index to section 600-699	50	A

Availability

The availability symbols in the right hand column mean:

A System documents are deposited with the
Directorate of Systems Design and Development (MCDT)
Deputy for Command and Management Systems
Hq. Electronic Systems Division
L. G. Hanscom Field
Bedford, Mass.

B Available through
Information Resources, Inc.
1675 Massachusetts Ave.
Cambridge, Mass. 02138

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Related Document	Information Mapping for Learning and Reference, by R. E. Horn, E. H. Nicol, J. C. Kleinman, and M. G. Grace, ESD-TR-69-296. August, 1969. AD699201. (Available from Information Resources, Inc.)
COBOL Draft	As part of the project, we also wrote a brief segment of a new subject matter in order to extend the range of topics to which Information Mapping has been applied. The subject matter was COBOL and the draft of this is available as part of the system documentation under availability A above.

THE GENERAL IDEA OF THE SYSTEM

Introduction

The proje to design a multipurpose system using Information Mapped data bases did not of course arise in a vacuum but in response to a felt need for more versatile training and reference materials in large computer facilities such as management information or military information systems.

Such instructional or training packages s are now available in these facilities are primarily sing -purpose programs serving all members of a given user class (such as initial learners) with almost identical information sequences.

The capabilities of a large computer facility, whatever its primary purpose, are such that it could be a significant source of information on all kinds of topics or subject-matter areas. Its capabilities are such also that it could be made to respond in a unique way to each individual in a variety of user classes.

It is against such a background that our initial thinking about system design took off.

The Computer Environment

In the design we assume the availability of a major multipurpose facility with certain characteristics which are described later. However, because a high degree of flexibility has been built into the design, certain versions can be implemented for smaller installations.

The Learning-Reference System then is planned to function either as part of a facility serving other purposes or alone as an information service mainly for educational, training and reference purposes.

The system design is not tied to any given computer but can be implemented on a variety of currently available machines.

Users of the System

The primary clients we intend to serve are those who are directly concerned with using the subject-matter materials in some way:

- for initial learning
- for reference work
- for reviewing
- for browsing
- for briefing.

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(continued) Users of the System	To serve these primary clients efficiently, the system must also be able to accommodate a <u>secondary class of users</u> who themselves serve the primary clients by operating the system, preparing new materials, gathering performance data, doing research -- in short: . training supervisors . course designers, authors, editors . computer programmers . clerical aides . researchers . updating specialists.
The Starting Point	As the design project got under way, then, certain aspects of the system were established or assumed -- we knew at least in a general way: . the kind of situation in which the system would operate . how the data base would be organized . the kinds of users it was to serve . some of the ways in which it should serve them.
Comment	From these outlines we began to work through to solutions on several issues involving teaching strategies and the control of information sequencing decisions.

20

SOME ISSUES RESOLVED

Introduction

When we consider how a sequence generator might be designed to serve the client who comes with a reference task, the problem seems fairly simple and straightforward -- make the sequence generator fetch blocks on the topics selected by the client from a table-of-contents display or an index display. In short, make the generator follow the user's directions.

But when we turn to the problem of how to serve the user who is learning something for the first time we encounter several troublesome interlocking issues of educational philosophy and teaching strategies.

Since one of the most important services of the Learning-Reference System is to provide instruction for the initial learner, we must consider what kind of role the sequence generator is to take with the learner.

Teaching Strategies

While educational philosophies with their various goals and teaching methods differ in many ways, it is their diversity of opinion on the amount of control to impose on the student that concerns us here.

At one end of the spectrum, educators are convinced that the only justifiable goal of education is to enable the individual to discover and develop his talents and to grow in confidence in his own capacity to find and learn whatever he wants. To produce independent learners, the role of the educational system is to provide the setting that encourages exploration and the exercise of individual choice and initiative with only a minimum of pressure from authorities or experts.

If our system were to serve a similar goal, the student would take charge of his own learning and direct the generator to bring the sequences he chooses -- again, the generator would be designed to follow directions.

Another variety of educational opinion holds rather similar views on the desirability of discovering and developing the talents of the individual but it goes about the task in a different way -- by testing and evaluating the student in order to plan a detailed program that the teacher believes will move him along toward greater development of his abilities.

A sequence generator to serve this philosophy would need provisions for testing and for performance recording, but most of all it would have to be able to prescribe sequences suitable for the student. The degree of control it would exert over the train of information displays and test items shown to the student would presumably vary in some prescribed way with the abilities and progress of the student.

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(continued) Teaching Strategies

At the other end of the educational spectrum are the fairly restrictive policies common to many conventional school systems ("compulsory education") in which courses and their proper sequencing are prescribed by authorities with only minor concessions to individual differences.

The sequence generator to serve such a system would follow fairly simple rules of testing and then presenting pre-programmed sequences of information, digressing from the path only for remedial sequences when test items are failed. Such a sequence generator would be suited to handling programmed instruction as well. Compulsory response and response evaluation would be required to keep the displays coming.

Many other in-between shades of opinion on the control issue exist but consideration of even these few points on the spectrum show that a sequence generator might be called upon to operate either under the client's direction or to assume full or partial control of sequence construction.

While most of the educational viewpoints alluded to above are concerned with long-range goals of transmitting the skills and knowledge that will serve the student over a long period, it is probable that even the strategies for achieving short-term goals will show a divergence of opinion on how much guidance to give the student.

The System Context

In reaching a decision on the design of controls within the sequence generator, we also reviewed the context in which the system may be operating and the kinds of people who may be operating it and being served by it.

Consider the environment in which the system may be used:

- in a general education facility in which
  - both long-term and short-term goals are sought, and in which
  - the educators in charge may differ concerning how much guidance and direction should be imposed on students
- in an industrial or military setting in which
  - training goals are paramount and the emphasis is on short-term mastery of specific information units, and
  - time constraints and other economic considerations may make system guidance of the individual the most feasible plan.

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(continued) The System Context

Regardless of the educational strategy that appeals to us personally, we have to recognize that system clients come from the real world and have been exposed to various educational practices. The clients may:

- range from totally docile students dependent on guidance at every step to those who have acquired some degree of independence and initiative, or
- be accustomed to setting up their own learning goals and to planning how to go about achieving them.

Conclusion

Build a system to provide:

- complete freedom for the independent learner
- varying levels of guidance for students who either ask for help themselves or are judged in need of it by the training supervisor.

For the system to respond intelligently with any degree of guidance means that it must have ways of evaluating the information needs and abilities of the student and that it then must know how to respond appropriately.

The design task then is to fashion the system mechanisms that will accomplish the above functions. (The design task is not concerned directly with the information contents of the system -- these can be as dull or exciting as the skills of the subject-matter writers permit.)

Comment

While our discussion of controlling information sequencing has been focussed mainly on serving the initial learner, other clients of the system may need or prefer guidance as well. For instance, the person who comes for review may prefer a guided review provided by the system. Later chapters will describe how various degrees of guidance have been made available to other classes of clients.

DESCRIPTION OF THE TARGET SYSTEM

Introduction

Once the control issue was settled, we examined other facets of the information services a system might offer and gradually evolved a statement of the main features of the system.

This description shows the general and specific functions we want the system to perform and the kinds of interactions it will have with various client groups. This is a more formal recapitulation of some points that have already been made. Some characteristics or functions are system-wide, others are specific to one class of users.

General Features

This system will work from a data base consisting of categorized information blocks that are organized into maps (sets of blocks), units (sets of maps), and courses (sets of units).

From such a common pool, it will generate information sequences that effectively meet the information needs of users with any of the following objectives: initial learning, reference work, reviewing, browsing, and briefing. Support personnel must be provided with the means for accomplishing their work as well.

The means by which the system determines the information needs of its clients will be described presently.

The function of calling up information blocks to be displayed to the user can be controlled:

- totally by the sequence generator
- totally by the user himself
- jointly by the user and the generator with various levels of dominance by one or the other being specifiable.

Clients without special training or previous computer experience will be able to utilize the information services of the system.

The system will be interactive in the sense that the user can:

- request and receive various kinds of information
- select from menus and indexes
- request an evaluation of his responses to practice questions
- indicate a preferred order for the display of information blocks from each map.

The fact that these capabilities will exist in the system does not mean that they will be operative at all times; in fact, when the sequence generator has the dominant role in sequencing decisions, some of these functions may not be permitted to the user.

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Initial Learning	The system will be capable of: . implementing different teaching strategies . assembling learning sequences to match each client's background knowledge, aptitudes, and attitudes . prescribing differentially for those who differ in how much of a subject matter they want to cover and in how well they want to learn it . testing a student's knowledge of the field and its prerequisites . providing feedback to the learner . providing remedial sequences when requested or when a specified failure rate on feedback questions is reached.
Reviewing	The system will be able to: . provide the user with a guided review tailored to his capabilities and objectives . supply support services to the independent reviewer who prefers to design his own review procedures.
Reference Use	The system will be able to help the reference user find the information he wants without needing special training on the system.
Browsing	The system will enable the potential student or the casual browser to explore the nature of any course in the system and to find out what might be required to learn it.
Support Services	The system will include special aids to simplify and systematize the work of those responsible for operating and maintaining the system.

COMPUTER REQUIREMENTS

Introduction	Although we have said that the Learning-Reference System has been designed without reference to a given computer, it does nevertheless require certain capabilities which are mentioned below. Although we envision the Learning-Reference System as part of a facility serving other purposes (management or command-and-control), there is no reason why a modified version of it could not function on a smaller scale serving only instructional/training purposes.
Hardware	In general terms the main requirements of the documented version of our system are these: . a third-generation digital computer or better . random-access secondary storage with read/write capability, including at least four tape drives . cathode ray tubes that are divisible into areas in order that text can remain on screen while other areas are changed . typewriter/teletype
Software	System software handles: . job-scheduling . multi-programming . time slicing . interrupt analysis . input-output . random access Standard utility programs include: . card to tape . tape to random access . sort-merge generator . report generator . assembler . library maintenance

26

DESIGN STRATEGY

Flexibility	In this first version, we did not expect the design of so complex a system to emerge full-blown from our drawing boards in untarnished perfection. Therefore we built into the system from the beginning the flexibility that would make it easy to change, add or delete aspects of the system. Flexibility was also required by the fact that at this stage the design was aimed at no particular computer. Whatever computer system it might be implemented on would naturally entail some modification of the design. Especially might this be so if the main work of the facility were not educational and this design would have to be fitted into the other functions. Flexibility in the design would also be a boon during the developmental testing period when the refinement of the system would be guided by performance data. The ways in which flexibility has been provided for will be mentioned at various points as the system is described in following chapters.
First Pass	Thus we intend in this first pass to sketch in with as much detail as possible those major structures of the system that are not hardware-related and to specify the interactions among the various components that will accomplish the system objectives. At times, relatively simple solutions were adopted for the present version because it would be economically unwise to devise more elaborate mechanisms at this stage. For example, in the present version we assume that the information blocks are written at a given readability level. With little difficulty, however, the same information blocks could be written at, say, three different reading levels to serve a wider range of clients. The modification required to permit selection of blocks from three parallel banks instead of from one is simple, albeit tedious, but little is to be gained now from spending the time to work out the extra details in the absence of any firm need and in ignorance of how an unspecified computer could handle the extra storage space requirements.
Summary of Strategy	In short, then, we take as our task the description of how major functions can be accomplished, leaving elaborations or more complex alternatives until such time as a specific computer facility may have need of them.
Comment	Certain of the design solutions accepted in this first pass merit explicit mention. They will be discussed in a separate map.

LIMITATIONS OF THE CURRENT VERSION

Introduction	In order to separate the problem of creating a gene 1 structure for the sequence generator from other more detailed p.oblems, we restricted the scope of this first version in several ways. These limitations and some of our rationale are discussed below. Throughout the pages of system documentation, it has been our practice to record notes concerning alternative solutions and possible directions for future extensions.
Displays	The sequence generator does not keep track of or control the positioning, color, size, flashing, brightness or underlining of any text on the display screen. We felt that selecting content for display was more important now than these other aspects which are dependent on system-specific characteristics. The design does assume that the amount of text displayed at one time will be adjustable by the client or by the system supervisor. In the future, we expect to have dynamic displays not only to illustrate processes or trends but to guide reading and analysis. If split-field scopes are available, other opportunities for creative use of displays open up. In some installations such scopes will serve as a more convenient response medium since in addition to the main display, they can offer simultaneously lists of topics or instructions from which the user can choose via lightpen action.
Computing	The computing capability of the computer has not been integrated into the design of the Learning-Reference System. Again, it is the nature of the specific computer that will determine how much of this capability can be put at the service of the user. Given sufficient capacity, the system can be amended to enable users to do on-line computations, problem solving, simulations and so on.
Time Control	The ability of the computer to keep track of the time duration of events in the system is useful in many ways, such as in keeping track of clients' behavior, identifying blocks that require an inordinate amount of time, and so on. There are teaching strategies also in which it may be desirable to put certain types of learners under time pressures. In this version of the system we make no attempt to formulate such refinements.
Printout Capability	It would be of obvious utility to the major clients to be able to take home hard copies of some materials. We expect this system to have such printout capability but its use and the nature of the controls that would be necessary have not been defined.

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Single Track

The sequence generator's present design operates on a single version of the information blocks in the data base. The blocks are written at a given level of reading difficulty. If the need arose to provide a wider range of levels, several versions of blocks could be prepared; either the supervisor or an internal decision rule could guide the generator to match the level with the individual user's capabilities. The simpler solution would be to treat each version as a separate course; pretests would determine which version was best suited to the client. Here the sequence generator would have the responsibility for assigning the user to courses.

The Supervisor

The role of supervisor has been created to perform certain functions concerned with getting the user established in the system initially and with determining how he will be treated by the sequence generator.

Eventually all of these functions can be handled by the generator. Through a computer-directed interview and testing program, the generator would gather the necessary user data and then refer to internal algorithms to find out how to interact with him in the session.

Teaching System Operation

At this time the sequence generator makes no coordinated effort to teach users about operating the system nor about Information-Mapping aspects of the information base. While we regard these as important aspects of the final system, they are of relatively low priority at this stage of refinement.

However, some provisions for explaining such things as the meaning of certain commands have been included in this present version. Otherwise, we assume that instructional materials about the system are present in the data base and can be called up just as any other course materials can be. In the final system, the sequence generator will be able to intrude hints about more effective use of the system into the interactions with the user.

Single Course Scope

This version of the generator copes only with the progress of the learner through a single course, although it does provide mechanisms for switching courses and communicating about courses. Later we expect that the generator will be able to utilize data from other courses that the user has taken in the system and that it will be able to supply some interesting effects as a result of indexing across courses.

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Long-Term Educational Objectives

At this stage of system design, our services to the initial learner do not include the teaching of those long-term educational goals that require prolonged exposure over courses to a teaching method or to a way of thinking. For example, we have in mind those long-range programs that are designed to promote the development of skills or of modes of thinking and problem solving.

Our first priority was to build a sequence generator that can cope with courses and units of courses where specific learning outcomes have been outlined and reflected in unit tests and review tests. While these latter need not concern the independent learner who is pursuing his own course, they do afford the sequence generator with the means for prescribing for those students whom it is guiding.

CHAPTER 2 INFORMATION MAPPING

OVERVIEW OF THIS CHAPTER

Introduction	Although Information Mapping was introduced briefly in the previous chapter, we need to take a closer look at it since it provides the basic building blocks for this Learning-Reference System.
This Chapter	The topics that concern us in this chapter are: . the main features of Information Maps and their origins . previous subject-matter applications and learning studies . general procedures for preparing Information Maps . special procedures that are needed to prepare maps for a computer-based system.
Comment	Information Mapping is a growing, changing set of procedures and policies. It is probable that experience with a wider range of subject matters and with an operational computer system will reveal the need for new categories and new procedures. This chapter then describes the <u>current</u> state of Information Mapping.

MAIN FEATURES OF INFORMATION MAPS

Introduction	Information Maps are conspicuous for their physical features, the format in which they present information. An equally important aspect of such Information Maps, however, is that the content itself is selected and organized according to a classification scheme and a set of analytical procedures. The method of presentation and the organization of content may be thought of as the visible and invisible features of a map.
Visible Features	The more obvious visible characteristics are these: · information is presented in blocks · marginal labels identify the kind of information in each block · a consistent format is used for each kind of information: procedures follow one format, concept maps follow another distinct format, and so on · functional and uniform headings and subheadings are used to make scanning easy and to speed up reference work · feedback questions and answers are located in close proximity to the relevant Information Maps · a local index at the end of maps provides map numbers for quick location of prerequisite topics. (Several of these features are not used in technical reports.)
Invisible Features	The arrangement and sequencing of materials presented in Information Map formats are the result of: · detailed specification of learning and reference objectives · specification of prerequisites for the subject-matter area

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MAIN FEATURES OF INFORMATION MAPS, continued

(continued) Invisible Features	. classification of the subject matter into component types (concepts, procedures, etc.) . definition of the contingencies required for successful learning and reference.
Footnote	This map and the four following ones are slightly modified versions of maps that appeared in the first account of Information Mapping by Horn, Nicol, Kleinman and Grace, 1969.

33

Introduction

Although Information Map features have their origins in several fields, there is no doubt that their principal foundations lie in education and learning research. On the chart below, we indicate briefly some of the findings that led to the design of certain Information Map features. This chart (which is not intended to be exhaustive) is one example of the research support behind Information Mapping.

Naturally, the evidence is not all of equal strength, but we have tried to bring to bear on a practical task some of the most promising factors.

Because the experimental basis for some map features is extensive, we cite wherever possible research review articles to put the reader in touch with the main sources of evidence. In the citations below, such major review articles are marked by asterisks to distinguish them from reports of original research.

These results of educational research lead to . . .	. . . these implications for the design of instructional materials.
Active responding generally aids learning. (Lumsdaine and May*, 1965; Briggs*, 1968; Glaser*, 1965) The act of writing responses helps some learners. (Edling*, 1968) Feedback or knowledge of results (or 'reinforcement') often facilitates learning by: · confirming or correcting learner's understanding · providing a motivational effect · improving scanning behavior (Lumsdaine and May*, 1965; Smith , 1964; Gagné and Rohwer*, 1969; Glaser*, 1965)	Insert feedback questions after introducing new materials. Locate answers conveniently nearby.

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INFORMATION MAP FEATURES DERIVED FROM LEARNING RESEARCH AND TEACHING PRACTICE, continued

These results of educational research lead to . . .	. . . these implications for the design of instructional materials.
The insertion of questions, "test-like events," <u>after</u> text segments has a positive effect on learning. Giving knowledge of results further increases the effect. (Gagné and Rohwer*, 1969; McKeachie*, 1963) Self-tests, pretests facilitate retention. (Glaser*, 1965; Briggs*, 1968; Bloom*, 1963)	Use feedback questions after maps with new information and use sets of review questions after natural clusters of maps and at the end of topic treatments. Provide answers as well.
In concept learning, a variety of examples promotes learning. (Gagné and Rohwer*, 1969; Lumsdaine*, 1963)	Use examples and nonexamples to point up differences and similarities among concepts.
Instructions are useful in calling learner's attention to important features. (Gagné and Rohwer*, 1969; Gagné, 1965)	Use introductory paragraphs or previews to alert learner to importance of upcoming ideas.
Judicious use of underlining often helps to focus attention on key elements. (Hershberger and Terry, 1963)	Underline important words in definitions.

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INFORMATION MAP FEATURES DERIVED FROM LEARNING RESEARCH AND TEACHING PRACTICE, continued

These results of educational research lead to . . .	. . . these implications for the design of instructional materials.
"Cueing" or labelling appears to aid by alerting learner to nature of upcoming information and informing him what his learning task is. (Glaser*, 1965)	Use marginal labels and informative map titles.
Pictorial materials often help learning. (Briggs*, 1968)	Use diagrams and drawings to illustrate concepts and procedures.
For some kinds of materials, charts of the information are valuable. (Feldman, 1965)	Use tables and verbal matrices to display concept relations.
Simple sentence structures in the active voice make learning easier. (Gagné and Rohwer*, 1969; Coleman, 1965)	In general, use active voice and simple sentences.

ORGANIZATION AND INTEGRATION OF INFORMATION IMPORTANT FOR LEARNING

Introduction

Some important features of information mapping owe their origins to a topic of current theoretical interest among learning psychologists - namely, the logical and psychological structures of knowledge and their impact on learning and retention.

Theoretical Discussions

Piaget had long ago speculated that "learning . . . is facilitated by presenting materials in a fashion amenable to organization" (Flavell, 1963), but it is only in recent years that psychologists have actively taken up the problems of how cognitive structures develop and of the role of organization in learning and retention.

The 'atomistic' approach of most programmed instruction materials has been criticized (Stafford and Combs, 1967) and a firm case made for the advantages of "meaningful organization and holistic presentation of materials."

In a symposium on "Education and the Structure of Knowledge" (Phi Delta Kappa, 1964), P.H. Phenix remarked: "It is difficult to imagine how any effective learning could take place without regard for the inherent patterns of what is to be learned."

David Ausubel (1960, 1963, 1964, 1968) has developed a logical and psychological case for believing that learning and long-term retention are facilitated by 'organizers' which provide an 'ideational scaffolding.' He has now amassed considerable experimental support for his hypotheses.

The well-known studies of Katona (1940) with college students pointed up the importance of organization for learning and for retention.

The relation of organization of materials to ease of learning also finds support in the area of verbal learning research (Underwood*, 1966).

Implications for Information Map Books

Although many issues remain to be settled by research, a strong case can be supported both logically and empirically for the advantages of organizing and integrating features in materials for learning. Both verbal and graphical means can be used to inject a sense of organization and direction into a subject-matter presentation.

In the practical effort to design effective learning materials, we have incorporated a number of features intended to help the learner integrate and organize the ideas for more efficient storage in memory. These are listed on the next page.

FEATURES TO AID IN ORGANIZATION AND INTEGRATION

Introduction

The following list of features designed to promote integration of concepts and relationships contains some that we have already adopted on other grounds. For instance, the guidelines called for practice questions and answers throughout the text because learning research suggested their value in several ways; but questions can also be phrased to encourage integration of ideas over sections of learning materials.

Examples of maps showing some of these features are given in the appendix.

List of Features

Features that aid in the organization of ideas are:

- reviews and previews: to take stock of the ideas developed up to that point and to prepare the ground for relating them to new concepts about to be encountered
- introductions to each map: to relate new idea to previous concepts or to familiarize with nature and importance of new idea
- recaps or capsules: to summarize succinctly the essential ideas of rules or principles in nutshell form
- tree diagrams: to sketch the ideas and procedures of a topic so as to show the role of each and its links to others
- compare-and-contrast tables: to point up the similarities and differences between two concepts that are sometimes confused
- summary tables: to chart in easy reference form the main concepts of an area
- review tests after short sets of maps and at the end of units: to promote the integration of several concepts and to practice using them in problem solving
- prerequisite charts: to show schematically the paths the learner can take through a subject matter in order to reach the learning objectives.

INFORMATION MAP FEATURES FOR EASE OF REFERENCE AND REVIEW

Introduction

In designing materials for initial learning, we added features to facilitate the return to ideas previously encountered, an activity that is often frustrating with conventional materials where the contents of the paragraphs are mostly unlabelled. Common sense, human factors research, and graphic technology were used in formulating aids for easy retrieval of information. A list of these aids appears below.

It is clear also that these same features would be important in Information Mapped <u>books</u> such as reference manuals or job aids. In the <u>computer-based</u> Learning-Reference System, these same features are still present, although they are of less importance because the sequence generator can take on the tasks of quickly locating information needed by referencers and reviewers.

List of Features

Features that aid in locating information are:

- Tables of Contents are organized and formatted to speed location of topics and special features. (This report does not use the standard format but follows certain ESD report requirements.)
- A predictable format for each type of map (concept, procedure, etc.) facilitates location of needed information.
- Map headings in consistent typography help in scanning for map topic.
- Marginal labels help not only in locating the kind of information sought but also in skipping that not required.
- "Related Pages" or local indexes at end of each map permit quick location of concepts prerequisite to the given map.
- Decision tables display the choices appropriate for each possible situation.
- Summary tables assemble main facts and relations for easy review and reference.
- Capsules provide "kernel" statements of key rules or concepts.
- Diagrams show graphically the sequences of events in a process or procedure.
- Indexes aid information retrieval.

EXPERIENCE WITH INFORMATION MAPPED MATERIALS

Introduction

Our experience with Information Mapped materials can be discussed under two headings:

- the range of subject matters to which the techniques have been applied
- the learning results from the use of these materials in research studies.

Subject-Matter Experience

Subject-matter experience is relevant to the Information Map classification system because this system evolved from attempts to categorize the kinds of topics dealt with in certain subject areas. Undoubtedly the kinds of information we have tried to handle will color the category scheme and undoubtedly we shall have to add terms when we confront entirely different subject-matter areas.

The major part of our experience has been gained in writing, testing, and revising a 150-page introduction to sets and probability. This book of mapped learning materials constitutes a ten-hour self-instructional course. It served as the basis for several research studies mentioned below. Recently several more units of approximately 100 pages have been added to it. Other volumes in the statistical field are currently in preparation.

The entire documentation for the Learning-Reference System has been written in Information Map form, as the previous chapter noted. It consists of several hundred pages.

The staff training/reference manual for Information Resources, Inc., is Information Mapped and so arranged that short courses can be assembled from it to suit the needs of various classes of new personnel, such as temporary typists, map writers, editors, updating clerks, and so on. These self-instructional materials may take as little as one hour for temporary typists or as much as several weeks for map writers.

Other subject areas with which the system has been tried are:

	APPROX. NO. OF INFOMAPS
• computer programming	75
• the binary number system	60
• CONVRS, an experimental computer language	150
• CANARD, a simulation language	150
• introduction to descriptive statistics	75
• introduction to matrix algebra	35
• permutations, combinations, and the binomial theorem	50
• introduction to COBOL (see p. 12 for availability)	25

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(continued) Subject-Matter Experience

In addition, brief units have been written for:

- basic concepts of operant conditioning
- some topics in American history
- two dentistry topics: how to extract a tooth, and periodontology
- a topic in chemistry: the structure of the atom
- the Munsel color system in art
- darkroom procedure in photography.

Learning Results

The Information Mapped book on sets and probability served as the research vehicle for several evaluative studies of initial learning by college students. The results (reported in Horn, Nicol, Kleinman, Grace, 1969) showed significant achievement scores and the students rated the materials attractive and valuable.

Although we have made no other formal studies of learning from Information Map books, the short training courses for staff personnel have been of considerable practical importance. Because the courses are self-instructional with self-tests and practice exercises, they enable us to obtain productive work from even temporary typists with only a minimum investment of staff time in training them.

MAP CLASSIFICATION RULES AND WRITING GUIDELINES

Introduction

Thus far we have talked about what Information Maps look like, how they came to look that way, what kinds of subject matters have been mapped and how maps have been used.

Now, in preparation for extending the ideas to computer data base organization, we must take up the topic of how Information Maps actually get made--how the content of a subject area gets transformed into labelled information blocks.

Planning

Most writing of information banks about a subject matter will probably start with writing for the beginning student who knows little or nothing about the area. Curriculum planning can proceed according to whatever educational philosophy the author prefers.

We suggest that eventually the outline of topics to be covered be translated into a prerequisite chart (see example, appendix), a schematic display that works backward from program objectives to the topics required to meet those objectives. Such a chart depicts in network format the relation of each concept or procedure to others and naturally suggests some sequencing possibilities.

From this chart the author works, following the extensive set of guidelines for writing, formatting, and classifying information. These guidelines also assist the author in identifying the materials that have to be written to serve reviewing, reference and browsing purposes as well.

The Mapping Guidelines

An important part of the Information Mapping documentation is the set of guidelines for classifying information and for writing the information blocks appropriate for the different types of maps. The guidelines themselves occupy several hundred pages (Information Mapped, of course) of format policies, instructions, and illustrations (reference given, Chapter 1 on page 11).

Tables showing the present classification of map types and permissible information blocks are given in the appendix to this report. These lists are not considered complete nor fixed for we regard Information Mapping as an evolving system. Wider experience with varied subject matters will show other categories that are needed to cover the information comfortably.

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(continued) The Mapping Guidelines

The guidelines originated with the need to specify rules and policies for writing book-type materials. In the course of the present project they have been extended to cover the preparation of information banks for the computerized system.

Various types of supplementary maps, that is, maps containing no new information, are required for initial learning and for reviewing, browsing and reference needs as well. Some of these maps are:

- previews
- reviews
- compare-and-contrast maps
- summaries
- decision charts

Tables of contents and indexes are also among the materials that have to be prepared. For all of these, writing rules, formatting policies and when-to-use guidelines have been documented.

Comment

While the guidelines suggest some principles that often make for effective writing, it is the author who must assume the ultimate responsibility for the style of writing in the blocks of his course. The course materials will probably be as varied in content and approach as are individual tutors--imaginative, boring, humorous, pompous, terse, verbose, challenging, trivial and so on.

Developmental Testing

No matter how inspired the formulation of guidelines may be, they can never eliminate the need for developmental testing. For all Information Mapped materials empirical testing and revision are standard policies.

MAPPING PROCEDURES FOR COMPUTER APPLICATIONS

Introduction

When Information Mapping is applied to the preparation and organization of computer information bases, certain new policies or procedures are required. Some of these are only slight variations of the rules for writing books but others entail extra writing tasks for the authors.

Documents

As the design for the Learning-Reference System evolved, the documentation of new writing requirements kept pace. This is kept up to date in the project document (cited in Chapter 1) and is available for the immediate training of course writers for the new system.

It is possible that in actual practice some of the map preparation tasks will be assumed by mapping specialists other than authors. For the present, we are concerned primarily with identifying the general nature of the procedures now needed in a computer application and not with allotting functions to personnel.

Modified Procedures

The guidelines for planning, writing and formatting Information Maps remain essentially the same. In writing for the computer setting, however, there is the additional requirement that blocks be independent in phrasing; since these blocks will eventually be assembled in unspecified configurations, we must avoid such phrases as "as we mentioned in the block above" or "the previous map explained...," and the like.

A major modification for the author is that he must prepare much more material for the computer base. Whereas in writing for a book he may find through experience that three or four worked examples are sufficient, with the computer system he will be dealing with a wider range of user abilities and thus needs a larger store of worked examples and practice exercises or feedback questions.

An earlier map mentioned that the author writing for the Learning-Reference System must also provide special maps for users with browsing, briefing, reference or review needs. This means that he will need to write information blocks about the course itself, including such materials as how much time it usually takes, what are its prerequisites, what are the main ideas and major applications (if any), and so on.

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New Writing Requirements

The main effect of the computer's advent into the picture is to increase the number of writing tasks. These may be categorized under two headings:

- telling the computer about various classes of potential users of the subject-matter materials, and
- telling the computer about various aspects of the information materials themselves.

User Characteristics

It is up to the author or subject-matter expert to record for the sequence generator any rules or recommendations he may have for handling users with different background characteristics. For example, the author of mathematical materials might recommend that initial learners with an antipathy for mathematics should be shown certain types of blocks that would be boring for learners who had a strong background in mathematics. Such advice from authors will be mainly of importance in dealing with initial learners.

Among the classes of information that an author might recommend as bearing on information sequencing decisions are these:

- intelligence quotient
- vocabulary level
- areas of major interest
- subject-matter competence
- attitude toward subject area
- job and socioeconomic status
- pretest scores

In each case in which the author formulates a relationship between user background data and sequencing treatment, it is his responsibility to specify as well <u>how</u> the user data are to be obtained. Some may be collected on-line using interview questionnaires or tests provided by the author or they may come from specified off-line sources and be entered into the computer by supervising personnel.

Pretesting will provide a major source of guidance to the sequence generator since it will have an influence on the selection of maps to display to the learner.

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Course Characteristics	Many characteristics of the course and its various parts have to be identified and stored in the computer in a fixed format in order for the sequence generator to carry out its task of assembling information blocks. Some of these characteristics must be indicated by the author while others can be supplied by support personnel. Some examples of the kind of information the authors must provide are: . difficulty rating for each feedback question . instructions for judging all possible user responses . instructions for remedial sequences following each incorrect response . possible following maps. Numerous characteristics of each course, map and information block must also be coded for the sequence generator but these can be determined by support personnel following routine checklist procedures.
Comment	More about the special aids to authors appears in Chapter 5. The various characteristics of users and courses will be encountered again in the next chapter where data base organization is described.

46

CHAPTER 3 THE CONCEPT OF A SEQUENCE GENERATOR

OVERVIEW OF THIS CHAPTER

Introduction

The heart of the Learning-Reference System is the executive program that acts as intermediary between the user and the stored information blocks. It can either fetch the information requested by the user or it can recommend suitable sequences for those who want or need guidance.

These functions are accomplished by a set of rules and procedures to which we have given the name "the sequence generator."

To respond to the different purposes of different kinds of users wanting to interact with different types of subject matters, the sequence generator must be capable of tapping a wide range of information if it is to deliver sequences of suitable displays.

This Chapter

The kinds of information the generator needs and the mechanisms that enable it to work are sketched out in this chapter. The command language comes in here also as the medium through which the user interacts with the generator.

The Next Chapter

In the next chapter we will show how the mechanisms enable the sequence generator actually to respond *individually* to the person who comes with a *learning* purpose in mind. How the system responds to *other* classes of users will be described in the following chapter.

A SEQUENCE GENERATOR: THE GENERAL IDEA

Introduction

If a common data base is to serve multiple purposes, there must be a guidance system for selecting, assembling and displaying those information blocks that are appropriate for each user's purpose and for his own unique pattern of capabilities, attitudes and personal preferences.

Definition

The sequence generator is the set of rules and procedures for selecting and arranging information blocks into a sequence of displays appropriate for a given user.

Nature of the Sequence Generator

The sequence generator is written as a series of decision tables that check on the values of certain stored data and then take the actions that are prescribed for the value configuration found.

The stored data are of many kinds:

- about the user, his abilities, preferences, and so forth
- about the system itself, how to use it, what kinds of materials it contains
- about each course and its various subdivisions even down to the individual information block and practice exercise
- about the state of the system at the moment as shown by various counters and indicators.

As the user interacts with the information base, the sequence generator keeps track of the action by updating the indicators and by entering new data into the system.

Example

Since the decision table is a key ingredient in the system, we illustrate it first in a very simple form. At the end of this chapter a more complex example will be given.

Let us imagine that the Learning-Reference System has been activated for the user and that the computer has asked the person to identify himself by typing his name and code number.

The computer must then examine the response to see whether the person is authorized to use the system. The way it does this is shown very simply in the following decision table which we arbitrarily entitle TABLE 100 WHO IS IT. The table is explained below.

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(continued)
Example

TABLE 100 WHO IS IT		1	2	3
CONDITIONS	Is his identification legal? (Does his response match any item on LEGAL CODE LIST?)	Y	N	N
	Has he given an illegal identification once? (What is the value of TIME FLAG?)		N	Y
ACTIONS	Display: "Illegal identification"		X	X
	Put Y (yes) into TIME FLAG (Shows one illegal identification given)		X	
	Display: "Identify yourself"		X	
	Put user's name into CURRENT USER STRING	X		
	GOTO TABLE 100 WHO IS IT		X	
	GOTO TABLE 105 WHICH MODE	X		
	Stop interaction			X

Explanation of Example

The top section of a decision table records the answers to questions about some current condition.

The lower section of a decision table shows what actions are to be taken for each relevant pattern of answers.

The table is read by considering the pattern of answers given in the first numbered column and then looking down the column to see what actions are prescribed (shown by X's). And so on, for each column.

In our example, when the answer to the first question is Yes, then we have no interest in the answer to the second question about whether an unacceptable answer was given before--that is why the answer box for the second question is left empty in Column 1.

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(continued) Explanation of Example

If the identification is legal, the computer takes the actions marked by X's in the lower half of Column 1, namely: the user's name is put into a computer storage location called "Current User String" and the computer goes to Table 105 WHICH MODE to find out whether the user's purpose is learning, browsing, reviewing, etc.

Column 2 in the table shows what the computer does if the user has given an illegal response to the first query--"NN" is the pattern of answers to the two questions. We see that the computer:

- tells the user the problem
- records in a place called TIME FLAG the fact that one illegal answer has been given
- again asks the user to identify himself, and
- then returns to step through this same table again.

If the user gives a proper code this time, we are of course back in Column 1; but if a false code is given a second time, we have the situation in Column 3: an illegal response has been given and the value of TIME FLAG tells the computer that this has happened once before. The computer then informs the user that his response is not legal and refuses to continue the interaction. (An accredited user who was making some error would presumably consult the supervisor at this point.)

This very simple example of a decision table illustrates two important points:

- the way that certain indicators within the computer get changed to keep track of events in interacting with the user--in this example, storage locations called "flags" and "strings" were modified

- the interlocking nature of the set of decision tables that we call the sequence generator--the example shows how the flow of action may go back through the same table again or may go on to other tables.

Comment

Although the actual decision tables of the Learning-Reference System are very much more complicated, even this simple example may give some feel for the way that a mere set of tables can constitute a sequence generator.

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(continued) Comment

The decision table offers the important advantage of flexibility which was discussed in the first chapter. An evolving system like this one needs components that may be modified easily without causing expensive changes in other structures or even in system documentation. It is easy to see that changing a line or column in a decision table would be simpler than changing a flow chart. Explicit procedures enabling support personnel to keep decision tables up to date are part of the aids supplied by the Documentation-Updating System described in a later chapter.

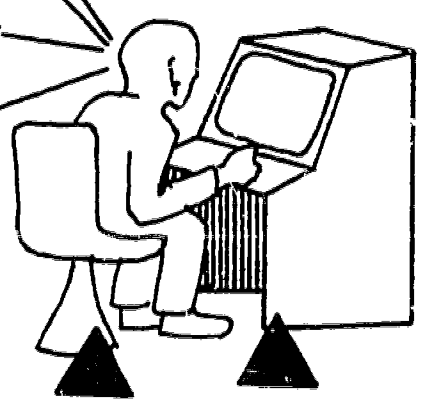
The use of decision tables simplifies the programmer's work since a number of compilers accept key-punched decision tables.

Later in this chapter we shall present a decision table of more complexity, but first we describe those other aspects of the system that provide the data for the decision tables.

SCHEMATIC OF THE INFORMATION MAP SEQUENCE GENERATOR

PRIMARY MODES OF INTERACTION

. Initial Learner
. Referencer
. Reviewer
. Browser
. Briefing



USER

TERMINAL SCOPE AND KEYBOARD

SUPPORT MODES

. Training Supervisor
. Editor
. Author
. Computer Programmer
. Clerical

The Sequence Generator finds out in which of these modes the user regards himself and provides appropriate services.

SEQUENCE GENERATOR PROGRAM	DATA BASES USED BY SEQUENCE GENERATOR
. responds to user commands and needs . sets goal and criteria . computes decisions about next displays . administers tests, evaluates results, and gives feed-back to user . provides routine updating of various data bases	Courses, composed of . Information Maps divided into . Information Blocks . Questions: . pretest . feedback . review User Data Bases for each user composed of . user back-ground data . current status . place-keeping data

Designed to operate not only under <u>total user control</u> and <u>total system control</u>, but also at <u>any one of numerous points in between</u>.

MODES OF OPERATION

Introduction

One of the primary objectives of the Learning-Reference System is to serve equally well users who come to the system for quite different reasons.

Within the sequence generator certain sets of decision tables and other mechanisms have been designed to serve each of the separate purposes for which users might come.

Description

A mode of operation is a set of rules for serving the needs of a particular type of user. It includes decision tables, switch settings and data storage locations especially designed to assemble the kind of displays needed by a given class of user.

Because the needs of user groups frequently overlap, the modes share many elements and computer routines. The mode requiring the most complex mechanisms is that for initial learning; hence this mode was designed first so that later modes could make use of its components.

In the current version of the sequence generator thirteen different modes have been tentatively defined and these are described briefly below. The modes for most primary clients of the system have been worked out in detail but some of the support modes have been defined only in general terms and may eventually be consolidated into two or three modes.

A mode is brought into operation by setting a "mode switch" to tell the sequence generator what kind of person is using the system. (At present such a switch setting would be made by a supervisor in consultation with the client, but this task will eventually be done automatically through a user-system dialogue.)

MODE	DESCRIPTION
Initial Learner	The purpose of this mode is to provide sequences of materials for those who come to learn something for the first time or to re-learn something mostly forgotten. A major goal is to deliver learning materials that are chosen especially to match the needs and interests of the individual. Whether the learner chooses his own path through the material or is guided to a greater or lesser degree by the tutorial provisions of the sequence generator depends upon a decision that is made by the supervisor or by the learner himself.

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MODE	DESCRIPTION
Referencer	The function of this mode is to enable a user to retrieve information from the data base easily and quickly. The user controls his interaction with the system and receives relatively little guidance from the generator except for some prompting when inappropriate commands are used or when he asks for help. The reference user needs little knowledge of the system since he can accomplish most tasks quickly with only four commands.
Reviewer	This mode serves those who wish to review a subject area they were once familiar with to some unspecified degree. It provides a user with : · a quick assessment of his knowledge of the subject area · an individualized review of those aspects that he has forgotten or wishes to see again · re-learning sequences where necessary either under system control or under the user's control. The aspects of the system that are to be controlled by the user or by the system are assigned by the supervisor or reviewer.
Briefing	Intended primarily for the potential user of another mode, this mode enables the individual to find out about the general nature and content of any subject matter stored in the system. The user of the briefing mode can see many special maps describing a given course, its difficulty level, an estimate of time required to learn it, some of the big ideas of the subject, its applications and so on. The degree of sequence control allocated to the user and to the system can be specified for this mode also.
Browser	Browsers need the tools to explore the information base in any manner they like. This means they need access to all courses. The system provides aids in terms of suggested commands and techniques that minimize the need for special training on the system. This mode has not been defined in detail.

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MODE	DESCRIPTION
Supervisor	The objective of this mode is to collect the information about a user that the sequence generator needs in order to serve him. The supervisor supplies the data required about the primary users and how they are to use the system. The information is obtained from the supervisor in a structured interview. Thus he has little need of the command language and little control over the system. As supervisor, he has no ing to do with instructional materials. Future versions expect the supervisor functions to be accomplished by internal algorithms and not by support personnel.

Explanatory Note: The following support modes have been described in general terms but they have not yet been implemented in decision-table form for this version of the system.

MODE	DESCRIPTION
Instructional Designer	These users have the responsibility for specifying the sequencing rules for learners who are guided by the sequence generator. The system provides such on-line aids as directed interviews for eliciting the required information from them.
Author	Authors create course materials. They work in English and need not be concerned with technical aspects of formatting. They may occasionally need to create blocks on-line, but in general they rarely interact with the sequence generator.
Editor	Editors need to be able to call up blocks on demand and to insert, delete, or replace materials. They have access to block usage summaries and to clients' comments on the materials.
Clerk	Clerical workers who prepare course materials for the computer work mainly with off-line keypunching or typewriting equipment. However, they may need to do on-line editing of the newly inserted materials. The system provides aids that make it unnecessary for them to learn many commands or details about operating the system.
Programmer	These users are charged with implementing the system design and with devising support programs. They need a thorough understanding of all facets of the system.

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MODE	DESCRIPTION
Researcher	These users need summaries of client-system interactions and various tables of data. They must have access to the user data bases. The system provides the support programs that enable them to extract the information they need in the form they prefer.
Proctor	Some versions of the system may operate with an attendant for the area in which user stations are located. Such personnel should be able to answer user questions, suggest courses of action, explain ambiguous situations and the like. They may need access to the user-system data in order to answer some questions about the interaction.

DOMINANCE CONTROLS

Introduction

Two pieces of information have a marked influence on the way the sequence generator treats the client--first, his purpose in coming as indicated by the mode he is going to operate in, and second, the degree of control the client is permitted to exercise over sequencing decisions.

The system is set up, as Chapter 1 explained, to operate at any point on the continuum that extends from total user control to total system control of the information displays.

Now we describe the mechanisms that tell the sequence generator just where on this continuum the current client stands and what aspects of the system (if any) he is to control.

Control Switches

The amount of control that the user is able to exercise over the system is defined by a series of "switches." Here a "switch" is not a physical knob-like or lever-like gadget, but it acts like one; it is actually a variable, a quantity stored in computer memory, that can take on different values just as a switch setting can. For instance, the Mode Switch tells the sequence generator what the user came for and it is "set" by inserting a number between 1 and 13 in the computer location called Mode Switch. The number 1 shows that the client is an initial learner, and so on.

Some other dimensions that are controlled by switches are such things as whether the client can use certain commands (such as to go forward or go back), whether he should see and/or pass feedback questions, whether he can change the order of block displays and so on. A full listing of the switches will be given later in this chapter after we have talked about the commands with which many switches are so closely associated.

In all, twenty-six aspects of system functioning are controlled by switches. Of these, approximately twenty aspects can be placed under control of the user or of the system itself by adjusting the appropriate switches. (The remaining switches are concerned with the user's goal, certain display options and the like, and are not relevant to the control issue per se.)

A switch may have two or more "settings." Complete control of his own path through the information can be put in the hands of the user by setting all switches toward the free end of the continuum. On the other hand the system can assume complete control of selecting displays if the switches are set toward the restricted end of the continuum. Numerous patterns of shared control can be achieved by the way the switches are adjusted.

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(continued) Control Switches

Not all switches are relevant for every mode; for instance, control dimensions for initial learning are determined by twenty or so switches, but for the review mode only eleven switches are involved and for the briefing mode six switches are sufficient to define different control aspects.

The variety of switch settings makes it possible to give enormous freedom to reference and browsing users and to retain various degrees of control over some initial learners.

The present version of the sequence generator design calls for these switches to be set initially by a training supervisor, who hopefully will take into account the background and preferences of the user when making the settings.

Later versions of the generator envision the switch-setting task performed by a series of internally stored algorithms which react to data obtained in a user-computer dialogue at the beginning of a session and to stored data from previous sessions with the user.

Control Levels

In this version where switch-setting is carried out by the supervisor, the control switches, each with two or more settings, are too numerous for the supervisor to cope with in a reasonable time span. Therefore, as a temporary measure, we have made up for the supervisor sets of switch-setting patterns to serve as guides for placing a client somewhere on the continuum ranging from total user control to total system control. From these sample patterns, demonstrating how to set up different levels of control, the supervisor can select the one best suited for his client. Then, working from this basic pattern, he can alter the relatively few switch settings that will make it serve the client more effectively.

In addition, some of the switches may be reset within a session as a result of the user's behavior (e.g., errorless performance) or at the user's request.

For initial learners, recommended switch patterns exemplify five "control levels," ranging from the level at which all sequencing decisions are made by the system to levels with increasing freedom for the learner and on up to the fifth level where he is in control of all sequencing decisions.

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(continued) Control Levels	For reviewers, on the other hand, fewer levels need be illustrated to make the supervisor's task more manageable. Throughout this report we will frequently use the term "control level" to refer to the relative degree of freedom experienced by a user in controlling sequencing. The term is not meant to imply a uniform pattern of switch settings for all users at a given "level" but only a relative position on a continuum. While users at a "restricted level" of control will have quite similar switch settings and those at the "free level" will have most of their switches set alike, the pattern in each case represents an individual prescription made by the supervisor for the particular user. The phrase "balanced level" is used sometimes to indicate switch positions that distribute the tasks of sequencing about equally to the user and to the system. Obviously many different switch patterns could qualify a user for such a designation. We shall come back to these relative control levels in the next two chapters where we see how the generator responds to the individual user in the different modes.
Comment	The kinds of information that influence the selection of a control level for each user and the kinds of data that the sequence generator draws on for its work are described in the next few maps.

DATA BASES USED BY THE SEQUENCE GENERATOR

Introduction

In order to accomplish its work the sequence generator must have access not only to the information blocks themselves but also to masses of information about many aspects of the system--details about the courses available, about the current users, about scoring each feedback question, about the number of blocks available for each map, and so on.

Such data are stored in a series of data bases. Each base contains a distinctive kind of information which is described briefly in the table below and more elaborately in the following maps.

Table of Data Bases

NAME	BRIEF DESCRIPTION OF CONTENTS
SYSTEM DATA BASE	Data pertaining to the total system (commands, map types, switches, etc.), information needed for all courses and users, and information about the contents of other data bases.
COURSE DATA BASE	Data describing the characteristics, content, and structure of each course; the information blocks themselves and answer evaluation materials.
USER DATA BASE	Permanent and changing data on each user, including background data, course performance records, and his status within an on-going session (switch settings and the like).

60

THE SYSTEM DATA BASE

Introduction

Certain classes of information about the system itself, its parts and functions are needed for general use. Such data are stored in the system data base.

Description

The system data base contains the following classes of information:

- the name and number of each course in the system and the total number of courses
- the name and code number of each user of the system and the total number of users
- the names and descriptions of all switches, including the function of each, the number of values it can have and the meaning of each value
- a store of messages from which the sequence generator can select one as a response to an action on the part of a user
- information about the command language and the actions to take when each term occurs
- the sequence generator itself (its decision tables and programs)
- statistical data across users and courses.

Examples of Uses

The sequence generator refers to system data in order to:

- select the correct course data base for a user
- determine the next available course number for an author to use
- locate the appropriate user data base for a person logging on
- allow switch settings to be made or changed
- display a message telling the user he has used an illegal command
- display a message informing the user whether his response to a question was correct or not
- provide summaries of system performance for researchers or programmers
- provide summaries of user performance for training supervisors or researchers.

THE COURSE DATA BASES

Introduction

Each course is organized into units.
Each unit is organized in terms of maps.
Each map is organized in terms of blocks and in terms of feedback questions as well because these require special treatment and evaluation.

Each of these structures and their contents must be described to the sequence generator so that it can select appropriate materials to display.

Description

To organize all this information systematically, a separate data base is established for every course in the system. The names and locations of these course data bases are specified in the system data base.

Each separate course data base consists of a hierarchy of smaller data bases for each structural part of the course.

Hierarchy of Structures Within Each Course Data Base

Each course data base is composed of:

- data pertaining to the whole course, such as:
  - table of contents
  - course index
  - prerequisite chart
  - objectives
  - main points
  - applications
  - overview and summaries
  - sample blocks and questions
  - difficulty level
  - time estimate for learning
  - final examination.
- the name, code number and location of every unit data base.

Each unit data base is composed of:

- data describing the unit to the sequence generator, including:
  - major concepts in the unit
  - unit pretest and review questions
  - prerequisite units
- the names, code number, and location of a data base for every map in the unit.

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(continued) Hierarchy of Structures Within Each Course Data Base

Each map data base contains:

- data describing the map, including:
  - map number
  - map type (concept, procedure, etc.)
  - blocks available
  - number of examples
  - possible following maps
- the information blocks themselves in display format
- the number of each feedback question and the location of the data describing it.

Each feedback question data base contains:

- data about the question, including:
  - relative difficulty on a scale from 1 to 5
  - possible answers that can be expected
  - the correct answer in the form preferred by the author (may be displayed as part of feedback to user)
  - the identity of the information block that is the basis for the question (block can be displayed again if question missed)
  - the number of times the user is allowed to try to answer the question.
- the question itself in display format.

USER DATA BASES

Introduction

Just as each course in the system has its own data base, so does each user of the system. It is here that all information pertaining to a specific user is stored for use by the sequence generator.

Description

The user data base describes the user to the sequence generator. It not only holds data about the person himself but it stores data about how the system treats him and about his current status in interacting with the information bank. Among the items contained in a user's data base are:

- background information such as:
  - name
  - age
  - sex
  - current job
  - reading level
  - mathematical level
  - areas of interest
  - achievement scores, attitude data, or other information a course designer believes related to information sequencing strategies
- data concerning user's experience with the system, including:
  - what course materials he has used and for what purposes (learning, reference, etc.)
  - performance records in Initial Learning or Review Modes
  - experience with the command language
  - the control levels at which he has been operating
- data concerning his current interaction with system materials, including:
  - the mode in which he is operating
  - name of the course
  - unit pretest scores if his purpose is learning or review
  - goal in terms of breadth of coverage (if relevant to the current mode)
  - criterion in terms of level of mastery sought (if relevant to the current mode)
  - switch settings (while the system data base contains general information about each switch and its possible values, the specific value each actually has for this individual on this occasion is stored in the user's own data base).

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(continued) Description	. data recording his path through the materials such as: . maps seen and passed . units passed . units failed . temporary data needed by the sequence generator in order to keep track of the user's current status and to conduct the session in an orderly, meaningful succession of displays, commands and responses. They include: . the number of blocks he has seen . list of maps whose prerequisites he has met . the name of the current map . the number of feedback questions failed . and many others.
Comment	The devices for managing some of these data classes and for keeping them current are important aspects of the Learning-Reference System. The next map describes more about how they function.

VARIABLE DATA SOURCES FOR THE SEQUENCE GENERATOR

Introduction

In the various data bases, we have said, the sequence generator finds not only the displayable information blocks themselves but also the detailed description of the information to be found at different levels of organization--courses, units, maps, blocks, feedback questions, and so on.

And we noted that an important data base is that reserved for details about each user--his capabilities, academic history, attitudes, experience with the system and so on. These are the details that influence the switch settings that determine how much control the user exerts over the sequencing.

But to assemble meaningful sequences of information, the generator must keep track of many things during a session. It needs other data sources in order to do such tasks as these:

- determine whether prerequisites have been met
- assemble blocks for the next map
- determine how many blocks to show at a time
- check on the legality of a command from a user
- evaluate the response to a feedback question
- determine whether the current map has been passed
- re-display a previous map that the user asks for again
- display a list of maps from which the user may select his next topic.

Several classes of variables have been defined to maintain the data needed.

Description

The term <u>variable</u> is used in computer programming to refer to several classes of memory locations whose contents are subject to change. In general the different kinds of variables (listed below) are used to keep track of changing conditions, the number of times events have occurred, lists of things that have been done or are yet to be accomplished and so on.

The data held in these memory registers are changed during an interaction with a user through the decision tables. The decision table example at the beginning of this chapter showed how flags and strings get changed. The switches, which we discussed earlier in reference to the control of information sequencing, belong to this group of variables also, but we shall save further description of them for a separate chart following the command language maps.

We do not give these tables with the expectation that readers will need this information, but rather with the idea that they might care to browse through to get a feeling for the kinds of tasks these variables help with.

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VARIABLE DATA SOURCES FOR THE SEQUENCE GENERATOR, continued

VARIABLES OF THE LEARNING-REFERENCE SYSTEM		
NAME	DEFINITION AND USE	EXAMPLES
string	any combination of letters or numbers;	CURRENT MAP STRING holds name of map the user is working on.
	mostly used to indicate names of courses or maps or blocks.	LAST STRING contains name of the last information block displayed.
list	an ordered set of strings or of other lists;	EXAMPLES SEEN LIST shows which examples from each map were actually displayed.
	mostly used to keep track of data about displays from maps--blocks seen, blocks available, blocks requested; feedback questions seen, passed, or failed; examples seen; ordering of blocks for display, and so on.	USER DISPLAY LIST gives in order the names of blocks routinely shown to a particular user.
		SUPPLEMENTARY BLOCKS REQUESTED LIST keeps track of the kinds of blocks the user asks for beyond those on his regular display list.
stack	a list that can be read at one end only; items are taken on or off from same end;	LAST MAP STACK saves map names for possible revisiting later.
	used for remembering map names and display conditions so that a user can return later; they also remember which units were passed or failed during pretesting.	LINK STACK saves map names and display conditions so that a user can return to his place after a brief excursion elsewhere.
		UNITS FAILED STACK keeps a list during unit pretesting.

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VARIABLE DATA SOURCES FOR THE SEQUENCE GENERATOR, continued

VARIABLES OF THE LEARNING-REFERENCE SYSTEM, continued		
NAME	DEFINITION AND USE	EXAMPLES
vector	a sequence of bits whose length equals the number of maps whose status it is remembering; mostly used to keep track of which maps in a course are to be shown to a user, which ones he has failed, passed, and so on.	GOAL VECTOR is as long as the number of maps in the course and the only bits that are turned on show which maps are recommended for the current user. MAPS SEEN VECTOR has as many bits as the number of maps in the user's course; all bits are off at first but as each map is seen, its bit is turned on. REVIEW VECTOR operates in the reviewer mode to keep track of units whose review questions were not passed at an acceptable level.
flag	flags are usually set to Y (yes) or N (no) to show whether or not some condition has been met; they remember what the user has done or whether the sequence generator has gone through a decision table before; they are also important in judging feedback questions and in showing whether commands are legal.	SIL TIME FLAG shows whether this is the first pass through the Start Initial Learner Table. GOAL MET FLAG is set to Y when the user has seen/passed all the maps indicated on his GOAL VECTOR. NEXT ONLY FLAG, when set to Y, indicates that NEXT is the only command legal for the user at that moment. GIVE RIGHT ANSWER FLAG, when set to Y, directs display of the correct answer to the current feedback question.

Comment — In the course of subsequent chapters more about the functioning of these variables will be illustrated as we see how the sequence generator interacts with several types of user.

THE COMMAND LANGUAGE

Introduction

In every machine-based instruction system, the user must have some means of communicating his instructions, questions or responses to the system.

The interactive Information-Mapped Learning-Reference System has two main ways in which a user can communicate:

- he can <u>type</u>
- he can <u>push a button</u>.

These response modes are used either singly or in combination to convey instructions to the sequence generator, such as:

- show me the next display
- go back to the last display
- give me another example
- let me see the index.

In actual practice such instructions are given not by such time-consuming phrases but by abbreviated commands: next, back, example, index.

Definition

The <u>command language</u> consists of a restricted set of terms defining specific instructions that the user can give to the computer. There are approximately two dozen commands in this set at the present time plus the names of information blocks which function as request commands.

Using the Language

Some commands are accomplished by pushing a command button (e.g. NEXT, STOP) or by using a button plus a typed phrase (REVIEW 6, GOTO 17) in which the number typed refers to a specific map.

The terms "command button" or "pushbutton" are used throughout this report but how these specific functions will actually be implemented will depend upon the nature of the particular computer facility. It is quite possible that the command terms might be selected not from a pushbutton bank but rather from a scope display of the appropriate terms; in this case a choice could be indicated with either a light pen or a teletype key.

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(continued) Using the Language	Typing is mainly limited to giving map numbers, block names, and certain letters or numbers in response to multiple-choice questions. English phrases or sentences would be typed only: . in answer to a test question that requires a constructed response . in a comment which can be typed in after using the REMARK command and which allows the user to record comments and suggestions about the materials or the system.
Restriction	The entire set of commands is not available to all users. To some extent the number that are permitted is a function of the degree of control the user is able to exercise over the system. In other words, the switch settings and certain flags can make some commands inoperable. For example, a certain class of user might not be allowed to use the command to change courses. Restrictions on command use vary also with the mode in which the system is operating. For instance, the reviewer is allowed to use those commands that enable him to list the kinds of information blocks he wants to see regularly; but a person operating in the briefing mode would not be permitted that option. The briefing mode user can however change courses at any time while other classes of clients are sometimes prevented from doing this.
Comment	Because commands and switches are very closely associated and because they both relate to the important issue of how display sequencing is controlled, we devote the next few pages to: . a chart of the commands and their meaning . a table of switches and what they accomplish.

70

THE KINDS OF COMMANDS OF THE COMMAND LANGUAGE

Introduction

Some commands are:

- executed by simply pushing the appropriate command button (e.g., NEXT, BACK)
- put into action by pushing the command button and typing some map number (e.g., GOTO 1, REVIEW 6) or block names
- interactive in that they enable the user to engage in a specific dialogue with the system (e.g., REMARK, SWITCH).

Classification Table of the Commands

The tables below give the name and a brief meaning of the instruction of each of the available commands.

SIMPLE COMMANDS	
NAME	MEANING
NEXT	Show the next display.
BLOCKNAME	Display a particular information block.
FEEDBACK	Display a feedback question from the current map.
TABLE OF CONTENTS	Display the Table of Contents for the current course.
INDEX	Display the Index for the current course.
ALL BLOCKS	Display all of the displayable information blocks from the current map. (Feedback questions are not shown.)
LAST MAP	Show all of the displays except feedback questions from the map that the user last saw before the current one.

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(continued) Classification Table of the Commands

SIMPLE COMMANDS (continued)	
NAME	MEANING
BACK	Show the previous display from the current map.
JUDGE	Evaluate the user's answer to a feedback question.
STOP	Stop the interaction for this session.
RETURN	Go back to where the user digressed.
POSSIBLE MAPS	Display a list of the maps that the user can see.
APPROPRIATE COMMANDS	Display a list of the commands that would be appropriate for the user to employ at this point.
BLOCKS AVAILABLE	Display a list of the information blocks available in the current map.
CURRENT DISPLAY	Display the names of the blocks on the USER DISPLAY LIST.
SUMMARY	Show a summary of the user's work.

BUTTON-PLUS-TYPE COMMANDS	
NAME	MEANING
GOTO "MAP"	Go to the first display of the map whose number is indicated.
REVIEW "MAP"	Display all of the blocks on the MINIMUM DISPLAY LIST of the map whose number is indicated.
DESCRIBE "COMMAND"	Display the map that describes the command indicated.
NORMAL DISPLAY	Change the USER DISPLAY LIST as indicated.

72 continued on next page

(continued) Classification Table of the Commands

INTERACTIVE COMMANDS	
NAME	MEANING
HELP	Provide suggestions as to how the user can better understand the material he is working on.
REMARK	Allow the user to make a comment.
SWITCH	Allow the user to change the value of one of his switch settings.
CHANGE COURSE	Allow the user to choose another course from the list of available courses.

SWITCHES USED BY THE SEQUENCE GENERATOR

Introduction

Switches tell the sequence generator, first of all, why the user came to the system, what his goal and criterion are (if applicable to his mode). After that, they mainly specify the degree of freedom appropriate for the individual user. Most restrictions are defined in terms of limits on the use of the language.

Just as some commands were not relevant for some modes, so also are some switches inapplicable in some modes.

The following table will give the reader an idea of the functions the switches serve.

Table of Switches

SWITCH NAME	MEANING	NUMBER OF SETTINGS AND EXAMPLES
CRITERION	level of mastery of course materials is set in terms of feedback questions that must be answered correctly in order to pass each map	6 settings, including . no feedback questions shown unless requested . must answer two successive questions correctly
GOAL	the breadth of course coverage is set in terms of what maps must be seen/passed to complete course	7 settings, including . no goal is set . pass major maps . see all maps . user selects those he wants to see/pass
MODE	identifies the user's purpose in coming to the system	13 settings, one for each of the modes defined earlier in this chapter
GOTO LIMIT	use of GOTO COMMAND can be limited to certain kinds of maps	13 settings, including . unlimited use . use only for maps passed . never use (system controls sequencing)
WHEN GOTO	specifies the times when use of GOTO is legal for the given individual	7 settings, including . anytime . not during a feedback question . never use

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SWITCHES USED BY THE SEQUENCE GENERATOR, continued

(continued) Table of Switches

SWITCH NAME	MEANING	NUMBER OF SETTINGS AND EXAMPLES
BACK LIMIT	specifies when the BACK COMMAND can be used	3 settings, including . never . only for displays within current map
BLOCK LIMIT	defines the times when user can ask for additional blocks (except feedback questions and examples)	6 settings, including . never . after required blocks on map have been seen . use anytime
CURRENT DISPLAY LIMIT	shows when user can ask to see which blocks are on his current map and in what order they will be shown	4 settings, including . never . not during a feedback question . anytime
POSSIBLE MAPS LIMIT	specifies when user can ask to see the list of the maps he has already seen	4 settings, including . never . not during a feedback question . anytime
NORMAL DISPLAY LIMIT	shows to what extent the user can use the NORMAL DISPLAY COMMAND to change the kinds of blocks and their order on his routine display list	7 settings, including . never . can only re-order blocks . can only add blocks . can change at will
EXAMPLE LIMIT	shows when additional examples can be requested	6 settings, including . never . only after all required blocks have been seen
EXAMPLE ORDER	shows whether to display easier or harder examples first	3 settings, including . easier first . harder first
FEEDBACK ORDER	shows whether to display easier or harder feedback questions first	3 settings, including . easier first . harder first

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(continued) Table of Switches.

SWITCH NAME	MEANING	NUMBER OF SETTINGS AND EXAMPLES
FEEDBACK LIMIT	specifies conditions under which user can ask for more feedback questions	6 settings, including . only after required blocks on given map have been seen . anytime
MAPS PASSED LIMIT	shows whether user must do more than meet his criterion in order to pass a map	4 settings, including . meet criterion only . must see all blocks from display list
DESCRIBE LIMIT	shows whether user may ask for the description of a command	4 settings, including . only when system suggests . anytime
REMARK LIMIT	shows whether user can record some comment about the system or materials	3 settings, including . never . anytime
TEACH LIMIT	defines how much on-line teaching of commands the system should provide	5 settings, including . only minimal prompting . teach only when user asks
BLOCKS AVAILABLE LIMIT	shows under what conditions the user may ask to see what other blocks are stored for the current map	6 settings, including . anytime except during a feedback question . never
REVIEW LIMIT	specifies which maps the user can see via the REVIEW COMMAND	6 settings, including . none . any map in current course or prerequisite course
SEE	records which of his switch settings the user is allowed to see	a vector with bits turned on for each switch setting user can see
MODIFY	specifies which switch settings the user can change	a vector with bits turned on for switches that may be modified

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SWITCHES USED BY THE SEQUENCE GENERATOR, continued

(continued) Table of Switches

SWITCH NAME	MEANING	NUMBER OF SETTINGS AND EXAMPLES
DISPLAY BLOCKS	tells how many blocks to display at one time	7 settings, including . one . all blocks except examples and feedback questions
LABEL BLOCKS	shows whether marginal labels of blocks are to be displayed	3 settings, including . yes . no
COURSE LIMIT	defines when user is allowed to change courses	5 settings, including . on system suggestion . at end of present course
SET	shows which switches are not yet set	a vector with turned-off bits showing which switches to set before user can begin session

77

KINDS OF DECISION TABLES

Introduction

Now that we are acquainted with the various kinds of data that the sequence generator must consult before delivering displays to the client, we can return to the topic of decision tables and consider some of the major functions that they accomplish.

Description

Three basic classes of decision tables in this system are:

- those concerned with initialization, getting the system set up to serve the client
- those concerned with display-response interaction during the session
- those concerned with termination of the session or the course.

Each class will be described briefly.

Initialization

When the user begins his interaction with the system, he is recognized and either his old data base is activated or a new one is established for him. The first example in the chapter showed how decision tables could accomplish that.

Probably even before the user logged on, the supervisor would have considered his background data, his purpose, and so on and would have set the various switches to establish his degrees of freedom and, if relevant to the mode, to set up a USER DISPLAY LIST, indicating the blocks from each map type that are suited to this individual's purpose and the order of displaying them. (The user may be allowed the freedom to change these.)

About a dozen or so decision tables enter into this phase of initialization. They check switches, set or unset flags, get the user's data base ready to receive new data, specify the minimum number of examples to be displayed, and so on. A simplified example of such a table is given at the end of this chapter.

Display-Response Interaction

The fundamental work for which the system was made takes place during the cycle of display followed by user action. The sequence generator presents a display; the user then responds by saying NEXT, or by expressing a desire for some other display or information.

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KINDS OF DECISION TABLES, continued

(continued) Display-Response Interaction	Two tables carry the main burden of this interplay: • Table 260 Displays • Table 135 Response. The first table relies upon several subtables to decide whether the user has passed a map or course, or what should be displayed next. The second table has various subtables to help it decide how to react to user's responses--they must identify the nature of the response; if it is a command, they must see if it is legal; if it is an answer to a question, they must see whether it is to be evaluated. In either situation they must find what action is prescribed by stepping through the sets of decision tables governing these aspects of the interaction.
Termination	When the user stops at the end of a session or a course, various housekeeping routines must be taken care of. Certain data collected about the user need to be saved for future occasions--as, for example, when he returns to continue from the point at which he stopped. These various chores are done by the third group of decision tables.
Status Comment	At present approximately one hundred two tables have been written for these tasks.

EXAMPLE OF A DECISION TABLE

Introduction	The entries in most of the decision tables of the sequence generator are more complex than those illustrated at the beginning of this chapter. Some tables have twenty or thirty columns and rows. Sometimes the cell entries are more varied than the simple Y, N and X shown earlier--digits may be used to indicate a wider range of values. For example, a user's aptitude might be indicated by H, M, or L to refer to high, medium or low. In the actions section of a decision table, digits might appear to show, for instance, how many examples are to be displayed. Most of the actual decision tables are unsuitable for illustrative purposes because they contain special terms or programming conventions and are not understandable without considerable study or familiarity with the variables that have been described in previous maps. The table chosen for illustration here does contain some special names for computer memory locations and it uses the backward arrow to say "put something into such-and-such a location." Nevertheless, it may give a feeling for the way the operating decision tables work and keep the interaction flowing from one table to another.
Purpose of the Table	Table 200, shown below, prepares the system to respond to the initial learner or reviewer. If the person has used the system before, this table brings up the relevant data that insure continuity in its interaction with him. For instance, under the heading of "fetch restart data," the system reinstates the conditions that existed at the last session--the display conditions, the switch settings, the status of vectors, strings, lists and so on. It initializes various memory locations. It calls upon other tables to perform special routines such as selecting a new course. It ends by transferring control to tables that will start up the displays for a learner or will interview the reviewer to find out his objectives.
Legend	The terms in upper case in the following table are system-specific, referring to memory locations, to variables or to other tables, which are distinguished also by the table number. For example, "DO 680 COURSE CHOICE" means that the computer should carry out the instructions given in Table 680, entitled, "Course Choice."

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EXAMPLE OF A DECISION TABLE, continued

200 START INITIAL LEARNER OR REVIEWER	1	2	3	4	5	6	7	8	9	10	11	12
(Has he already used the table today?) Value of SIL TIME FLAG?	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y
(Is he ready to start a course?) Value of START NEW COURSE user attribute?	N	N	N	N	Y	Y	N	N	N	N	Y	Y
(Is he ready to select a new course?) Value of CHOOSE NEW COURSE user attribute?	N	N	Y	Y	-	-	N	N	Y	Y	-	-
(What type of user is he?) Value of MODE SWITCH? 1 Initial learner 7 Reviewer	1	7	1	7	1	7	1	7	1	7	1	7
(Show that table has been used today.) SIL TIME FLAG ← Y	-	-	X	X	X	X	X	X	-	-	-	-
(Set up the cross course data.) DO 250 DATA THERE	-	-	X	X	X	X	X	X	-	-	-	-
Fetch user restart data	X	X	-	-	-	-	X	X	-	-	-	-
DO 680 COURSE CHOICE	-	-	X	X	-	-	-	-	X	X		
DO 203 CREATE USER RESTART DATA	-	-	X	X	X	X	-	-	X	X	X	X
START NEW COURSE ← N CHOOSE NEW COURSE ← N CURRENT MAP STRING ← NAME OF FIRST MAP DISPLAY STACK ← USER DISPLAY LIST (TYPE STRING)	-	-	X	X	X	X	-	-	X	X	X	X
GOTO 260 DISPLAYS	X	-	X	-	X	-	X	-	X	-	X	-
GOTO 551 REVIEWER INTERVIEW	-	X	-	X	-	X	-	X	-	X	-	X

81

CHAPTER 4 THE SYSTEM'S RESPONSE TO THE INDIVIDUAL LEARNER

OVERVIEW OF THIS CHAPTER

Introduction	Now that the major elements and functions of the Learning-Reference System have been introduced, we shall follow the system in its interactions with several representative clients. This may convey a clearer picture of the workings of the system in concrete situations.
This Chapter	The topic of individualized instruction is a convenient one around which to organize a fuller description of the system's capacities because it affords opportunities to demonstrate some of the options available to users or to system managers. Although all sequences are drawn from the same pool of organized information blocks, the sequence generator assembles quite different configurations of blocks for each individual. The factors and processes responsible for the differences in information delivered are pointed up in this chapter. The stage is set in the early phases of initialization when the supervisor and the generator come to various decisions about how the new client is to be treated. The first part of the chapter deals with that process. To illustrate the differential response of the generator to the user, the hypothetical cases of three initial learners are traced next. A summary map draws together the various dimensions along which individualization occurs in this system.
The Next Chapter	Other classes of clients who come with information needs are also treated on an individual basis. This chapter describes some typical interactions of the system with these users.

GETTING THE LEARNER STARTED IN THE SYSTEM

Introduction

An important part of making the sequence generator responsive to the individual consists in telling the generator about the person the first time he comes to the system. This is accomplished by a series of tasks assigned at present to the supervisor and slated eventually to be performed by the generator itself after on-line interviewing and testing of the client.

In the present version of the system, the supervisor's work is simplified by a computer-directed interview in which the generator elicits from the supervisor the information it needs in the form in which it will be used.

Initial Tasks

In the following cluster of maps we shall describe the tasks involved in starting a new learner. They include:

- deciding on how control of sequencing is to be allocated to the system and to the client
- establishing the learner's objectives in terms of the breadth of subject matter he wants to cover and the level of mastery he wants to achieve
- specifying the mode (initial learning) and the first course the learner wants to see
- collecting various background data about the learner in order to set up appropriate display recipes
- pretesting the client in order to start him at the proper point in the course.

How each of these tasks is done is discussed in the next group of maps. Fortunately the actual work can be done more quickly than it can be described.

For clients who have used the system before, the system has retained their initial data and has added to it the records of their work in the system. Thus for them the initializing chores are quickly dispatched.

ESTABLISHING A CONTROL-ALLOCATING POLICY FOR THE FACILITY

Introduction

We have a system that can provide varying levels of guidance for its clients or can leave them free to use the system as they will.

Whether a level of control will ever be imposed upon users or whether they are to choose the guidance level they wish is a matter of policy for facility managers to determine.

Some Relevant Factors

Some of the factors that bear upon establishing a policy on this issue are:

- the purpose of the facility--whether it is concerned with educational or training objectives
- whether any job requirements are related to courses passed
- the attitude of the administrators toward teaching strategies
- cost factors for operating the facility--where training time per person is important, restrictions may be imposed
- customer load--a facility that has queues may need to restrict the time allowance for each user.

The various factors interact in affecting the decision reached by the managers. The latter may establish a uniform policy for the system or a mixed one with differences defined for time periods or user classes.

In the examples in this chapter, a supervisor presides over setting up control levels for the user and we shall assume that his actions reflect the facility policy.

SELECTING A CONTROL LEVEL FOR THE LEARNER

Introduction

The level of control determines how the learner will interact with the system. In this version of the generator where the supervisor sets the control switches initially, he must take into account certain information about the learner. He may find what he needs in the user's data base if the learner has been there before, or he may have to collect it from the learner himself or from other sources.

Factors Influencing Control Selection

Some of the factors that enter into the choice of control or guidance level are these:

- user's history of independence or experience in managing own learning program
- user's experience with this system and skill with the language
- user's own wishes
- facility policy (as noted in the last map).

The learner's wishes may include such considerations as his own time pressures or a desire to expand his acquaintance with the system. In the first case, he may have only a short time to learn something and, even though experienced with the system, he may prefer to be guided along the shortest path commensurate with his goals. In the second instance, he can be assigned to a guidance level that gives him a chance to expand his understanding of commands gradually while he concentrates on his main learning task.

The amount of control that the user is allowed to exercise over the system should be compatible with his ability to make efficient use of it. It should not put demands on him that distract him from his main objective.

The level selected can of course be changed if the user finds it uncomfortable and in any case, switch settings may change through the course of a session as a result of the learner's performance or behavior patterns.

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Future Plans	In planning one's own learning program, the amount of freedom or self-direction that is optimal is not now known. It will probably be found to vary with characteristics of the learner and with his stage of development. One attractive feature of the Learning-Reference System of the future is the opportunities it offers for a practical research attack on this problem. With its facilities for allocating degrees of control, for measuring learner's progress, for recording interactions, and for printing out data summaries for many variables, it is well situated to enlighten our understanding of the control issue.
Comment	How the quality of the learner's experience differs for certain control levels will be illustrated presently in examples of some representative users. First we finish explaining the process of preparing the system initially to respond to the user.

DETERMINING THE LEARNER'S OBJECTIVES

Introduction

The next important information the generator needs to know about the user is the nature of his objectives. Unless it knows these, it will not know how much of a subject matter to cover in its presentations.

The learner may come to the system for a variety of purposes. He may seek complete mastery of the subject area, or he may want only an understanding of the main ideas and a knowledge of where to find details when he needs them. He may want an even more general bird's-eye view of the subject.

The sequence generator must be able to bring sequences that are appropriate for the objectives of each individual.

Setting the Learner's Goal

In order to give the sequence generator the specific datum it needs, we can arbitrarily define goals in terms of several configurations of maps that would serve different objectives. Some plausible combinations of maps are:

- all maps of the course
- major maps--those presenting the main concepts of the course
- general maps--the previews, reviews, summaries and the like.

The grouping that seems best suited to serving the learner's goal can be selected and indicated to the sequence generator by setting the Goal Switch, one of the twenty-six switches mentioned in the last chapter. For instance, the switch could be set to 2 to indicate the second combination above. This selection would also be automatically reflected in the Goal Vector which is set up to show the generator which maps in a course can be drawn upon for displays.

The above groupings of maps are examples of the fact that different combinations can be earmarked to serve different objectives. It would be the responsibility of the course designer to tag maps that are suited for different goal statements. The sequence generator will be guided by the Goal Switch setting and the associated Goal Vector to pick out all maps with similar tags.

The Goal Switch could be set as the result of a dialog between the learner and the computer, but for the present version, the supervisor confers with the user about his objectives and then sets the switch.

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(continued) Setting the Learner's Goal	In the case of those learners who operate near the free end of the control continuum, they can set up their own Goal Vectors in a dialog with the computer. Basically what happens is that the learner selects from a table of contents the names of the maps he believes he will want to see. The numbers of these maps are tagged in his Goal Vector and the generator will derive displays from them.
Setting the Learner's Criterion	The user's goal determines what information he will be exposed to, but how well he must learn that information is specified by a criterion. The criterion in the Learning-Reference System is a statement of a level of proficiency needed in order to "pass" each map shown. This idea of "passing a map" is stated in terms of the number of feedback questions that the user must see and/or answer correctly. Here again a switch is used to select a level that is desirable for the specific individual's situation. The levels range from virtually no requirements at all for passing a map other than just seeing it, to the stipulation that two correct responses in a row are required before the user can go on to another map. (The requirement to pass feedback questions carries with it the implication that remedial sequences will be supplied until criterion is met.) As the table of switches in the last chapter shows, the criterion switch has six settings at the present time; others could be added and the settings could be made to change in the course of a session as a result of the learner's performance. Research in this area will help in formulating the algorithms that can set the criterion automatically in the future.
Comment	Taking the goal and criterion settings together, we have the means of making the generator responsive to the individual's learning objectives. A person, for example, who was preparing for an important closed-book examination might specify that he wanted to cover all maps of the course and to pass each by correctly answering two successive feedback questions. On the other hand, the student who wanted only an understanding of the main ideas in order to prepare for an open-book test might ask for major maps only, and he might set a criterion of one correct answer to a feedback question merely to verify his understanding of the related map.

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(continued) Comment	Another user might want only a general picture of a subject, but one that was rather more detailed than that provided by the briefing mode. In this case he could ask that the generator show him all general maps but no feedback questions unless instructed to do so by the user.

PREPARING THE USER DISPLAY LIST

Introduction

Since each learner comes to the system with his own objectives and with his unique personal characteristics, the system should be able to create for him a pattern of information blocks that is tailored to his needs. The generator would not display for him all the stored blocks belonging to a given map but would select only those that serve the user's purpose.

To do this the generator sets up for each client a list of the blocks that it will routinely show from each type of map. This list, the User Display List, is prepared after the generator consults background data in the user data base or collects the information itself.

User Data

For each course, the course designer may specify certain personal data that will influence decisions about building displays for the individual. These data may be obtained via questionnaires, proficiency tests, miniature situation tests, aptitude and attitude tests and so forth, either given on-line or off-line. The nature of these tests, the scoring of them and the decisions to be taken for given score ranges will be specified by the course designer.

For example, if the course were one in the math area, the designer might supply an attitude-toward-math scale and prescribe that students below a certain score be given designated sets of blocks from each map in order to allay their fears of the subject area. But for learners with extensive training and proficiency in mathematics, he might prescribe a minimum display list consisting, for example, of only definition block, diagram and notation blocks, plus one example with a higher difficulty rating.

All such prescriptions are recorded in the course data bases. They are elicited from course designers in computer-directed interviews or via printed questionnaires.

Defining the User Display List

The <u>User Display List</u> contains the names of specific information blocks in the order in which they will be displayed for the particular user. The names always refer to the current map type (e.g., concept map, procedure map).

As the starting point for preparing a User Display List, the generator builds upon the Minimum Display List, a list that is defined in the system data base as constituting the minimum display allowed from the given map type. For example, let us

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(continued) Defining the User Display List

say that for a concept map the Minimum Display List consists of

- name
- definition/description
- formula
- notat-
- example.

(If a block named does not exist for a given map, it is simply ignored when the display list is used.)

After considering the current client's background data, the generator adds blocks to establish the User Display List:

- name
- introduction
- definition/description
- example
- formula
- notation
- example.

The user's data base may show that in past sessions this user has had a tendency to request display of "Use" blocks, for example; in such a case, that block may be made part of his display list.

Use of the Display List

The generator consults the User Display List to determine:

- which blocks to display and in what order they should be shown

- whether all blocks have been displayed when the user presses certain command buttons (under some control settings, commands will not be accepted until the recommended blocks have been shown).

Changing the User Display List

The User Display List is a list of recommended blocks but, except for the client from the most restricted control level, there are many possibilities for modifying it. We are concerned now only with establishing it in the first place. As we will see presently, the user's experience with it and his personal preferences may mold it much more precisely to satisfying his individual information requirements.

SETTING UP DISPLAY CONDITIONS

Introduction

Before the learner finally begins his interaction with the information base, there remain a few additional chores. For one thing, several more aspects of the displays have to be mentioned to the generator. And it has to be told where to begin building displays.

Display Details

For both example blocks and feedback questions, the supervisor can recommend the difficulty level from which the items are selected for display. As the table of switches in the last chapter noted, he chooses whether easier or harder items are shown first. Under the freer control conditions, the learner himself makes these choices.

In an Information-Mapped book, the marginal labels for the information blocks are convenient for reference purposes. There is also some research that suggests that to be alerted to the nature of upcoming information facilitates learning. Nevertheless individual preferences or research purposes make it advantageous to be able to suppress or display the label. The Label Blocks Switch permits the choice and its setting is left up to the user (except in controlled research).

One more important switch remains to be set--that telling the generator how many blocks to display at a time. The present switch settings can specify from one at a time to all blocks at once (from the User Display List), and may be selected either by the supervisor or by the learner, depending upon how the control level is set.

In actual implementation in a computer facility, the display options will become much more varied and important. Since these are so closely tied to specific hardware, this version of the generator is concerned with nothing more than the number of blocks to display at a time.

Starting Place

Each initial learner beginning a new course takes a pretest (unless he is operating under the freest control conditions). This test allows the system to determine the current state of his knowledge about a subject.

The sequence generator uses the results of the pretest (which are stored in terms of unit scores) to determine on which unit the user should begin. Those units that have been passed in the pretest are bypassed by the learner but maps from them may be called up if he wishes to check on his grasp of some idea in them.

Comment

To illustrate how the interaction with the system differs for individuals whose initial settings are quite different, we will follow the sessions of three imaginary learners in the next few maps.

A LEARNER OPERATING AT THE RESTRICTED CONTROL LEVEL

Introduction

Suppose our first fictional learner, Ted, has been assigned to the most restricted level of control in which the generator makes the sequencing decisions. We shall see how the system was initialized for him and then describe the kinds of things he can and cannot do in a learning session.

Initial Setup

Ted came to the system for a course in probability. Through on-line testing and interviewing, the following facts about him emerged that led the supervisor to set up the system in this way:

These Characteristics Led...	...To These Settings
. dependent, docile learner . has never used this system . is in a hurry	Control Switches to Restricted Position except Feedback Limit Switch is set to allow any feedback question requests
. wants only main ideas . high level of mastery	Goal Switch: See Major Maps Only Criterion Switch: Pass 2 consecutive feedback questions per map
. math aptitude score=85% . lacks confidence in math ability . little interest in math . asks one example to be shown before definition	User Display List: Introduction, Example, Definition, Notation, Diagram, Comment, Example Examples and Feedback Questions: easier ones first
. prefers display of two blocks at a time	Block Display Number: Set at 2 (exclusive of Map Name block and Related Maps block)
. prerequisite test passed . all unit pretests failed	Starting Map: first major map of Unit 1.

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Explanation of Settings

Ted is assigned to the restricted control level because he is unfamiliar with the system and in a hurry. If he had more time and expected to use the system often, some switches could have been set to allow him more leeway in using commands and to enable the system to prompt him on their proper use.

Or the supervisor might have urged him to take first the short course on operating the system. However, since he has little time, the system is now set up to guide him through the materials as swiftly as possible to achieve the goal he has indicated.

Because he lacks confidence in his math ability in spite of creditable test scores, the generator follows a prescription stored by the course designer and sets up a User Display List containing both Introduction and Comment blocks. These often supply interesting context and extra learning aids that may increase his confidence. Two examples were prescribed for the same reason.

The Learning Session

The session starts with a very brief introduction to the system, explaining the block structure of the displays and the use of the few basic commands he will need.

The course begins with the first major map of the first unit. The first display shows the Name and Introduction blocks and an easy example.

After reading these blocks, Ted has only a few options -- he can push:

- NEXT button to replace the present display with the next two blocks
- APPROPRIATE COMMANDS button to see what commands he can use now
- STOP button to bail out of the session.

If he makes the usual response of pushing NEXT, the displays will continue to appear two at a time until he has seen the blocks from that map that were prescribed on his User Display List.

Then the feedback questions come up one at a time until he answers two in a row correctly (according to his Criterion). When he answers incorrectly, the generator follows the directions stored by the author in the feedback-question data base -- it may show again the block from which the missed question was derived or it may take some other recommended action.

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(continued) The Learning Session

Now a new option becomes available to the learner -- he may ask for more feedback questions if he wishes, because the Feedback Limit switch setting permits this.

From the second map on, he can use the LAST MAP command to bring up again the last map he saw. This command and NEXT are the two commands that enable him to move the displays -- but the distance he can move them is very limited. He can back up only to the just previous map and he can move ahead through the blocks of his current map. Until the required feedback questions are correctly answered, he cannot call up the next map.

These restrictions keep him on the path prescribed for him initially and prevent him from side excursions. For some educational purposes this may not be wise but for certain training objectives it is advantageous.

If, as the session proceeds, Ted consistently answers feedback questions correctly, the generator may change to the more difficult questions and may omit the second example from the User Display List.

Ted continues through a session with few variations except that he can ask for help with the HELP button and he can use the command to get a summary of his session showing how many maps or units he has passed and how much remains to be done.

When he wants to stop, he pushes the STOP button; the generator stores away all data concerning his display conditions, his place in the course and relevant lists, stacks, strings, flags. These are kept in Ted's assigned data base so that on the next occasion he can resume where he left off.

Individual Treatment

Under these restricted conditions, the learning experience <u>feels</u> to Ted very much like a session of computer-based programmed instruction. He was allowed a handful of extra choices perhaps, but otherwise he was locked into sequences assembled by the generator.

But as a matter of actual fact, the sequences Ted saw were prescribed for him as an <u>individual</u> -- he was <u>not</u> pushed through, in programmed-instruction manner, a standard series shown to everybody except for occasional remedial side trips. His sequences were tailored with an eye to his objectives, his attitudes, his prerequisite skills, his personal preferences, and even to his present situation -- a specific information need and a time limit.

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(continued) Individual Treatment

In addition, before Ted returns for another session, the supervisor or curriculum specialist may review the records of his interaction with the course materials and may insert into his data base changes in switch settings or display conditions that will make the pattern of the next session even more suitable for his current status. In a later version of the system, such adjustments will be made automatically by the generator.

Another student assigned to this same restricted level might see a markedly different set of blocks from the same course. A person who was proficient and confident in mathematics, for instance, might have a short display list consisting of the minimum allowable blocks and he might have no requirement to answer feedback questions, depending upon his objectives in taking the course.

A LEARNER OPERATING AT A BALANCED CONTROL LEVEL

Introduction

Our second imaginary learner, Dick, has been assigned to the control level at which some sequencing tasks are performed by the system while others are assigned to Dick. It must be remembered that the setup for Dick is only one of the many quite different switch-setting patterns that are possible at this level.

Initial Setup

Dick also comes to learn probability but he seeks just a general understanding of the major ideas for his own reasons. He has taken three previous courses on this system. His stored data show that he has a good background in mathematics and is not intimidated by it. He is a moderately dependent learner but aspires to be more self-directed. In the previous courses with the system, he worked at a fairly restricted control level because he did not know the command language well. He has completed the on-line pretest for probability and has passed unit 1 at the 80% correct level, but for other units he passed less than 50% of the questions.

In conversation with the supervisor, Dick explains his objectives with regard to probability materials and his wish to assume more control over his learning experiences.

In view of these various data about Dick, the supervisor adjusts the system initially to enable him to:

- make his own Goal and Criterion setting
- specify whether easier or harder examples and feedback questions should be displayed first
- indicate how many blocks he wants displayed at a time
- set up his own User Display List naming the blocks he wants to see from each map.

Dick decided to set his Goal to "see all maps" and his Criterion to pass one of the more difficult feedback questions. Because of his switch settings, he is free to change these at any time if he is not satisfied with them.

The supervisor, in view of Dick's learning history, sets certain command switches to limit his ability to jump about at will in the course materials -- he can move forward only to maps for which he has passed the prerequisite maps. Whenever several maps are eligible, he may select the one he wants to take up next.

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(continued) Initial Setup	He may use all commands but a few cannot be used when a response to a feedback question is expected. The system is also set up to tutor him on commands and strategies in order to increase his skill and confidence in handling the system.
Actions He Can Take	During the learning session, a few of the more important actions that Dick can take are these: . use the GOTO command to see any map for which he has met prerequisites . use the RETURN command to go back to the place where his digression began . back up to a previous display from the current map . select a topic from the Possible Maps List except when asked to answer a question . ask for additional blocks to be shown from current map . add, delete or reorder the blocks on his User Display List . ask for explanation of commands . record remarks about the material, the system, his progress and the like . consult the table of contents and the index.
Actions He Cannot Take	Few things are forbidden to a user at Dick's level except that in his case switch settings specify that: . he cannot jump ahead to maps he is not prepared for . he cannot change a few switches . he cannot avoid displays of feedback after answering feedback questions . he cannot change courses (a decision of the supervisor's).
Comment	An example of Dick's interaction with the system during a learning session is charted on the next map.

SAMPLE SESSION OF A LEARNER AT A BALANCED CONTROL LEVEL

Introduction	To give an impression of how a session might proceed, we present a sample of the interaction between Dick and the computer. The example is constructed to show some of the variety of actions Dick can take; in actual practice one would hope that he would pursue a less erratic course.
Initial Setup	To recap the display situation set up in the preceding map, mainly by Dick's own choices: Goal: See all maps Criterion: Pass one feedback question per map User Display List: Definition, Notation, Diagram, One Example Examples and Feedback Questions: Display harder ones first Blocks at a Time: Display two Course: Introduction to Probability.
Format	To save space, the information blocks themselves are indicated only by their labels in parentheses; the user's answers to feedback questions are similarly indicated. Actual map names and displays of computer remarks to Dick are given in regular text format. The commands Dick uses are given in upper case. Explanations are added on the right when appropriate.

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SAMPLE SESSION OF A LEARNER AT A BALANCED CONTROL LEVEL, continued

	SEQUENCE	EXPLANATION
Display:	Events. Map 25 (Definition block) (Notation block)	The first map from Unit 2 is shown (Unit 1 having been passed in the pretest). Blocks indicated on User Display List are shown two at a time.
User:	NEXT	
Display:	Events. Map 25 (Example block) (Related Maps block)	Map 25 has no Diagram block, generator displays next available block. (Feedback questions are not shown at same time as blocks.) Related Maps block, a local index showing location of main concepts relevant to the given map, is automatically displayed at end of each map.
User:	NEXT	
Display:	(Feedback Question)	
User:	(Answer) NEXT	
Display:	Your answer is correct. Push NEXT to continue.	The criterion of one correct answer has been met; Map 25 is recorded as "passed."
User:	GOTO 17	Dick wants to review a concept in Unit 1 which he had passed. Related Maps listing helped him locate it quickly.
Display:	Sample Space, Sample Points. Map 17 (Definition block) (Notation block)	
User:	RETURN	Dick learned what he wanted from the first two blocks, stops display of remaining blocks by asking to return to his previous place.
Display:	Empty Event. Map 26 (Definition block) (Notation block)	Since Dick had passed Map 25, the computer continues with the next scheduled map.

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SAMPLE SESSION OF A LEARNER AT A BALANCED CONTROL LEVEL, continued

	SEQUENCE	EXPLANATION
User:	NEXT	
Display:	Empty Event. Map 26 (Example block) (Related Maps block)	
User:	BLOCKS AVAILABLE	This command gets the generator to list the names of all blocks available on the current map.
Display:	Empty Event. Map 26 Blocks Available Introduction Definition Notation Comment Example Non-Example	
User:	COMMENT	
Display:	Empty Event. Map 26 (Comment block)	
User:	NORMAL DISPLAY DEFINITION NOTATION DIAGRAM EXAMPLE COMMENT	User wants to make Comment blocks a regular part of his Display List in the order shown.
Display:	New Display List recorded.	
User:	NEXT	
Display:	(Feedback question, Map 26)	
User:	(Answer) NEXT	
Display:	No, that is not correct. (Notation block) (Feedback question)	The block on which the question was based is displayed again. A different feedback question on the same point is displayed as well.
User:	(Answer) NEXT	
Display:	That is correct now. Elementary Events. Map 27 (Definition block) (Example)	Map 26 recorded as passed. Notation and Diagram blocks not available for this short Map 27.

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SAMPLE SESSION OF A LEARNER AT A BALANCED CONTROL LEVEL, continued

	SEQUENCE	EXPLANATION
User:	NEXT	
Display:	Elementary Events. Map 27 (Comment block) (Related Pages block)	
User:	GOTO 34	Without passing Map 27, Dick asks to jump ahead to another topic.
Display:	Sorry, you have not passed prerequisites.	
User:	POSSIBLE MAPS	This command will get Dick the list of those maps that he is eligible to call up.
Display:	The following maps are those for which you have met all prerequisites. Asterisks mark those you have already seen and passed: Number Map Name 25 *Events 26 *Empty Events 27 Elementary Events 28 The Union of Two or More Events 29 Elementary Events Form Other Events 30 The Intersection of Two or More Events	
User:	GOTO 30	
Display:	The Intersection of Two or More Events. Map 30 (Definition block) (Notation block)	Dick prefers to take up this topic next rather than the one the generator chose for him originally.
User:	FEEDBACK QUESTION	Since Dick has the concept, he forestalls display of the other blocks by asking for a question.

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SAMPLE SESSION OF A LEARNER AT A BALANCED CONTROL LEVEL, continued

	SEQUENCE	EXPLANATION
Display:	(Feedback question Map 30)	
User:	(Answer) NEXT	
Display:	Right. Continue.	Map 30 joins Maps Passed List.
User:	STOP	
Display:	Your current status is: Passed: 25,26,30 Other Possible Maps: 27,28,29,31 This record will be kept for your next session.	Status and all display conditions, lists, flags, etc., stored for next occasion.

A LEARNER OPERATING AT THE FREE CONTROL LEVEL

Introduction

Our third imaginary learner is Henry, who is an old hand at manipulating this system as well as being a self-reliant person accustomed to setting up his own objectives and a plan for achieving them. The supervisor has intelligently adjusted the system so as to give Henry carte blanche. Let us see what help the generator can offer Henry.

Initial Setup

Any learner at this free level of control can use any command and set any switch he wishes at any time. Whether he wants to set up a Goal and a Criterion is completely up to him.

Henry's situation is this: he wants to prepare for the Graduate Record Examination. Although he is well prepared in mathematics, he knows little about probability.

His first move is to take on-line the pretest for the Introductory Probability course. Units 1 and 2 are passed at a 90% level which satisfies him. His concern now is to learn more about units 3 to 5. Rather than set any Goal or Criterion or display conditions now, he begins the learning session in his own way.

Learning Session

Henry changes the Mode Switch to the briefing mode setting. He then quickly runs over the main points of the probability course, its objectives and the course summary.

Once he has the big picture of what the course is about, he returns to the Initial Learner Mode by changing the Mode Switch.

Now he uses the goal and criterion functions of the system to design his own course. He calls for the table of contents, checks off the names of maps that he wishes to see. These go into his Goal Vector so that each of them comes up in order unless he chooses to deviate from his plan.

Because he is competent in mathematics, he sets no "passing" criterion but merely asks to be shown two difficult feedback questions for each map.

Also because of his good background in mathematics, he sets up for himself only the Minimum Display List: Definition, Notation, Diagram, One Example.

He sets the switches to display all blocks at a time, keeping the labels attached.

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(continued) Learning Session

Now he begins study of the displays from Unit 3, using the NEXT command to move the maps along on the scope. At any time he is free to depart from the sequence he has established. He may pursue related ideas to previous units or go ahead to unseen and unpassed materials.

He may call up additional blocks any time he wishes or he may design a new User Display List.

If, on reading feedback questions, he feels uncertain about the answer, he can give his response and by use of the JUDGE command, can get feedback concerning his correctness. (Ordinarily, he does not need feedback for he knows when he understands.)

He may call for the next unit pretest, if he likes, to satisfy himself about his progress in that area. His scores have no automatic effect on his procedures -- he can adjust his strategy or not, as he wishes.

If he forgets the meaning of certain terms in the command language, he can ask for help at any time. He may even leave the probability course and revisit the course on how to operate the system.

He is free to record remarks about any aspects of the materials, of the system, or of his own progress.

He may discard his systematic approach to the unpassed units of the course -- he might, for instance, call up the feedback questions for maps picked at random from the table of contents. Only when he is ignorant of the answer would he call up the information blocks from the map in question.

After a series of experiences of that sort, he may resume an orderly inspection of the materials in each unit. He is free to follow whatever strategy appeals to him at the moment -- even to choosing a completely guided tour of the subject area, such as a learner at the most restricted level might receive.

Comment

The generator is designed to help the self-reliant learner in many ways. The system is also designed to improve its services in response to user's remarks and suggestions and in response to research summaries of operational data.

Future plans for the system include the addition of special materials and simulation games designed to encourage students to become self-reliant managers of their own learning experiences.

SUMMARY OF THE SYSTEM'S RESPONSE TO THE INDIVIDUAL LEARNER

Introduction

The initial learner in the Learning-Reference System is treated as an individual because the sequence generator acts on many kinds of data that are specific to the person.

This table summarizes those factors about the learner that make a difference in system functioning. (Control switch settings modify the effect of some factors.)

THESE FACTORS. . . . . AFFECT. . . .	THESE SYSTEM COMPONENTS
I. User's Objectives	
• purpose in entering system--to learn: • general nature of subject area • entire subject matter • main ideas of the subject	Goal Switch
• proficiency level • thorough mastery for long-term retention • general understanding • other	Criterion Switch
II. User's Background Data	
• independence and experience in planning own learning experiences • proficiency in using this system and the language • user's wishes	Control Level
• experience in subject area in terms of courses and their difficulty level • proficiency in subject area in terms of prerequisite test scores • attitude toward subject area in terms of questionnaire scores • other cognitive and motivational aspects judged relevant by course designer, such as reading level, intelligence level • stored records of past command usage or other behavior tendencies	User Display List Number of Examples and Feedback Questions Their Difficulty Level
• user preferences	Display of Block Labels Number of Blocks Shown at a Time
• pretest scores	First Map Display

SUMMARY OF THE SYSTEM'S RESPONSE TO THE INDIVIDUAL LEARNER, continued

THESE FACTORS. . . . . AFFECT. . . .	.THESE SYSTEM COMPONENTS
III. <u>Learner's In-Session Choices</u> (Depending on Control Level)	
• request additional blocks for current map • request more feedback questions/examples • modify User Display List by adding, deleting or re-ordering blocks • return to previously seen or passed maps • call up table of contents and index • select next topic from list of maps whose prerequisites have been met • explore course materials at will (free control level only) • enter comments into the system • request session summary • ask for help of several kinds • request description of command use • request suggestions of possible next commands • modify display conditions (number of blocks, label display) • suppress display of answer evaluation (feedback) • modify switch settings	Decision Table Usage Switch Settings
IV. <u>Learner's Response Patterns</u>	
• feedback failure rate	User Display List Number of Worked Examples Number of Feedback Questions Remedial Sequences
• block order preferences • additional block requests	User Display List
• command usage record	Instruction by System

CHAPTER 5 THE SYSTEM'S RESPONSE TO INDIVIDUAL USERS OF OTHER CLASSES

OVERVIEW OF THIS CHAPTER

Introduction	The Learning-Reference System is equipped to give custom-tailored service to users other than initial learners. In order to do this it has special features that serve a given user class but it also relies heavily on the mechanisms that generate displays for the individual learner.
This Chapter	This chapter explains how individualized treatment is accomplished for clients who come for reference, review or briefing purposes. A few of the special aids to supervisors, writers/editors, and researchers are described also.

THE REVIEWER MODE

Introduction

One of the primary purposes of the Learning-Reference System is to help the user review materials that he has previously learned. In many respects the operating mode that caters to reviewers resembles the Initial Learning Mode and it does use some of the same mechanisms.

Description

The Reviewer Mode is designed to give the user a guided review of course materials or to help him review in whatever way he wishes. Whether or not he is allowed a choice depends upon the supervisor.

The Guided Review

The guided review, whether chosen by the user or assigned to him, takes into account various kinds of information about the reviewer and his objectives in much the same way as was done for the initial learner.

The reviewer may come for a number of reasons. He may want to go over some information he expects to need in his occupation. Or he may have to instruct others and wish to refresh his memory first. Or, as a member of the academic world, he may find reviewing useful before taking exams or writing term papers. He may even have some humble purpose such as killing time.

His objectives and certain other personal characteristics enter into the supervisor's deliberations when he sets up the system to serve this person. As with initial learners, the supervisor considers the user's experience in operating this system, his self-reliance, and his wishes in regard to planning his own review.

Sets of review questions for each course unit serve as the basis for certain sequencing decisions for users in the guided review condition. The reviewer can be required to pass a specified percentage of unit review questions, depending upon his objectives. If he is reviewing in preparation for an exam, he might want to pass 90 per cent of the review questions before leaving the system. Units that are not passed at the specified level are shown again.

A guided review session very much resembles a restricted initial learner's session in that the reviewer has:

- a criterion that shows what percentage of review questions he wants to pass before leaving the unit
- a Goal Vector that shows the sequence generator the list of maps he is scheduled to see because he missed review questions based on them
- a User Display List that shows what blocks from each map are to be routinely displayed to him.

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(continued) The Guided Review

If the supervisor's switch settings permit it, the reviewer can change his display list, ask for other blocks, go forward or backward in the course materials. He may ask for feedback questions and they may be evaluated but they do not influence the sequencing of displays--only review questions affect that.

In short, the generator in the guided review condition finds out what the person does not know and then takes him through relearning sequences that are tailored for his particular objectives and personal background.

Free Review Condition

Unrestricted reviewers can go through the materials more or less as they wish. They may be as free as the top level initial learner or the referencer. All commands are available to them.

Many different strategies can be used. For example, reviewers can set up in advance the list of maps they want to see. This can be done by selecting from the table of contents or it can be based on the results of optional pretests. Maps indicated by the reviewer would be set into his Goal Vector and then the generator would go through the series with him. He can use feedback questions or not, as he wishes. In any case, they would not affect his sequencing plan.

Another reviewer might want to look over only the general maps in a course--the overviews, previews, summaries, compare-and-contrast tables and the like. These could be set into his Goal Vector to save having to ask for each one individually in the session.

Some may like to review by testing themselves on a feedback question from each map. Only when they miss or feel uncertain would they call for information blocks from the related map.

The reviewer whose switch settings allow him complete freedom is even free to ask for a guided review.

In short, the free review condition helps the reviewer follow any strategy he prefers. If his skill in manipulating the system is weak, the generator can be set to teach him that also.

THE REFERENCER MODE

Introduction

The Learning-Reference System provides a number of features to facilitate the retrieval of information from the course data base. The person who comes to the system with a reference problem is served by the Referencer Mode whose primary objective is to provide quick location of those concepts, procedures and so forth that are relevant to the user's question or problem.

Brief Description

Most often referencers approach the system with specific questions in mind and in many cases speed of retrieval is important. To accomplish his search, the system allows the referencer the greatest amount of freedom in selecting the materials he wants to see. When the user logs on and the Mode Switch is set to Referencer, then automatically all relevant switches are set at the free end of the control continuum and all commands are legal for the referencer to use.

The Inexperienced User

Basically the referencer does not have to know very much about the system in order to retrieve the information that he is seeking. When his interaction with the system begins, the generator asks him to select a course and then shows this display:

TO FIND WHAT YOU WANT, YOU GIVE COMMANDS BY PUSHING COMMAND BUTTONS AND BY TYPING.

- TO SEE THE INDEX, PUSH THE INDEX BUTTON.
- TO SEE THE TABLE OF CONTENTS, PUSH THE BUTTON WITH THAT LABEL.
- TO SELECT INFORMATION YOU WANT TO SEE, PUSH THE GOTO BUTTON AND THEN TYPE THE NAME OR NUMBER OF THE MAP YOU WANT.
- TO CHANGE COURSES, PUSH THE CHANGE COURSE BUTTON.

TO FIND OUT WHAT OTHER COMMANDS DO, PUSH THE "DESCRIBE" BUTTON AND THEN PUSH THE BUTTON WHOSE FUNCTION YOU WANT TO KNOW ABOUT.

If the user inserts an inappropriate command, the system will prompt him by suggesting commands that might be more useful.

When the referencer uses the GOTO command, the generator shows all blocks from that map except feedback questions. If the user wants to see those he must use the FEEDBACK command.

continued on next page

111

The Experienced User

The person who is experienced in operating the system can use some additional techniques to save himself time.

If, for instance, he knows that he has a series of things to look up, he can set up his own Goal Vector so that the maps he wants to see are tagged for display. Otherwise, he would have to consult the table of contents and use the GOTO command to bring up each map in the series.

If the referencer wants to check his understanding of a map concept, he can ask for a feedback question to be displayed. He does not have to answer it, but he may if he chooses and he may also ask for evaluation of his answer by pushing the JUDGE command. His answer, whether right or wrong, has no effect on the sequencing of displays because the referencer has no requirements he must meet.

Future Plans

Few concrete data are available concerning the behavior of those who are doing reference work. We expect that by debriefing interviews and by keeping a record of certain data on the commands used by those in the Referencer Mode, we may learn of modifications that may serve this user class more efficiently.

FOOTNOTE ON THE BROWSING MODE

Introduction

Originally project objectives included a provision for designing services that would enable a person to browse through the information base of a computer system in the way that he would browse in a library or bookstore.

Browsing Behavior

Patterns of browsing behavior have never been very well documented, although J. C. R. Licklider has suggested some experimental studies of browsing in order that automated libraries will not destroy this rewarding pursuit (Intrex, ed. by Overhage, C.F., and Harman, R.J., M.I.T. Press, 1965).

When we considered the kinds of things we ourselves did when browsing among books, we noted such things as being attracted to a book because of its arresting cover design, the presence of either a favorite topic or of a strange, puzzling term in its title, and so on.

At the present time we see no services needed by the browser that are not now provided by the Referencer Mode. The initial single display describing the four or five needed commands and then the free control settings should be quite sufficient to let the browser explore the information base at will. He would need access to all courses and it may be found that for him additional system-wide indexes and tables of contents are required.

Future Plans

For research purposes, it might prove valuable to keep separate records of browsing and reference behaviors. That can easily be done by having the user log in and be counted as a browser, and then program control would be shifted to referencer decision tables. Until additional needs of browsers have been identified, we plan to give no further attention to this mode.

THE BRIEFING MODE

Introduction

One of the primary purposes of the Briefing Mode is to acquaint users with the general nature and content of any course in the system. The generator can provide special materials and sample lessons to enable the user to:

- learn generally what the course is about
- compare one course with another
- decide whether he wishes to take the course in the role of either learner or reviewer.

Description

In order to show the general nature of a course, the generator can present information about:

- the difficulty level of the course
- names of prerequisite courses
- number of maps in the course
- the time estimated for completing the course as a learner
- course objectives
- the main points or big ideas of the course
- overviews and previews of some units
- sample lessons and sample tests.

These kinds of information are stored in every course data base, as Chapter 3 mentioned. The author of each course is responsible for providing the details and also for tagging other maps that are suitable for briefing purposes.

Formal Briefing

Since some who might want to use this mode may not know how to operate the system and use the commands, the system offers a formal briefing in which the sequence generator takes charge of selecting displays. The client may indicate how much time he wants to spend and the presentation will be adjusted accordingly.

Only a few commands are available for the person who receives the formal briefing--he can of course use NEXT to move the display along and he can ask for the table of contents and index. He can record comments, ask for help, change courses and stop. Otherwise the displays are totally determined by the sequence generator.

The Unrestricted User

The unrestricted user is free to explore the course material as he wishes. The system can suggest certain types of overview and general materials that are appropriate and it offers certain aids such as the "course comparison table" that permits him to check the dimensions along which he would like to compare two courses. For example, he might like to see how two courses compare on the items listed in the Description block above. The comparison table can be displayed to him or can be printed for him to examine off-line.

OTHER USER CLASSES

Introduction

Although the design of modes for support personnel was outside the scope of the present project, it was natural that we should begin to see something of their outlines as we filled in the picture for the primary clients. Some support functions were occasionally worked out in detail, others were sketched in only in a tentative way.

Just how these other modes will cater to the individual needs of the users is not fully clear yet, but the techniques can be expected to parallel those of the other modes. In addition, special aids will be made available for some functions.

We report the general status of these modes here.

Supervisor Mode

Because of the important role played temporarily by the supervisor in this first version, a number of functions of the supervisor have been implemented through the decision-table level. This degree of detail was useful in conceptualizing how future versions could automatically accomplish these same tasks.

The major function of the supervisor is to provide the sequence generator with all the information it needs in order to serve a newcomer to the system.

While it is easy to conceive of a set of professional requirements desirable in a training supervisor, the specific tasks assigned temporarily to this supervisor require little educational expertise and only superficial acquaintance with this system itself. In other words, we are concerned at the moment with the minimum that a supervisor must do to set the system displays going for a user.

The system has the capability at present to deal with a hierarchy of supervisors in which the operations of more experienced supervisors are less restricted. Nevertheless, the main work of any supervisor is accomplished through an on-line interview in which the system asks for the information it needs.

It asks for specific data, prompts the supervisor on unset switches, and displays menus from which he can select the alternative appropriate for the given user. Thus little burden is put on the supervisor's memory or training background.

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Writing, Editing Modes

Several classes of support personnel may be needed to prepare course materials for the system: authors, instructional designers, editors, key-punch operators and programmers. Space has been tentatively allotted for separate modes for each of these user classes, but it is most likely that the functions will be combined into one or two modes that can serve them all.

Several existing languages have been considered with regard to their suitability for authors and instructional designers in this system, and some sets of requirements have been compiled; however an in-depth study leading to solution of this issue was not within the purview of this project.

The author aids that have been designed so far include a demonstration set of questionnaires to guide authors in giving the generator every last detail it needs about each information block. The data required for even one feedback question is tedious to such a numbing degree that only a structured form and preferably an automated procedure can prevent careless omissions.

(Each feedback question is accompanied by such details as these: its associated map, its number, name of block it is based on, its difficulty rating, the number of different answers expected, the different answers themselves to be matched against the user's response, the correct answer, actions to be taken for the different possible answers, display messages geared to the response alternatives, the number of times the user can try answering, and various flag and switch settings to indicate sequencing or display instructions.)

For all personnel engaged in preparing course materials--from the instructional designer to the key-punch operator--the intention is to streamline their tasks by making procedures explicit, and by providing special commands and system guidance that will enable them to function with a minimum of special training on this system.

Researcher Mode

The system is built to retain detailed records of each user's interaction with the system--not only his identity, personal data, location, date, time and purpose, but also his path through the materials, blocks called for, command usage, performance data, control conditions, display conditions, feedback conditions, and so on.

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(continued) Researcher Mode	Such data are not only essential for both system and information improvement but they are a gold mine for research purposes. They can be almost useless unless the researcher is given the tools to tabulate and summarize them in the form he requires. Future plans call for programs that enable the researcher to extract what he needs with a minimum of special system training. Special commands, displays of data-condensing options, computation packages, provisions for off-line processing and printout formatting choices are some of the potential aids that could make the Learning-Reference System a first-class research facility.

SUMMARY OF GENERAL INDIVIDUALIZATION STRATEGY

The General Strategy

Whether the user be a prime client or one of the support personnel classes, the general strategy followed in programming the generator is the same: to make it respond to each individual by basing its actions in part on:

- the user's objectives, capabilities, and wishes
- his familiarity with the system
- the current state of his knowledge of the area in which he is operating.

Varying degrees of system guidance can be chosen or assigned. Built-in aids--computer-directed interviews, brief operating instruction sequences, questionnaires, and explicit step-by-step procedures for some modes--all are designed for the purpose of making each user's experience with the system as effective and effortless as possible.

CHAPTER 6 CREATING AND MAINTAINING SYSTEM DOCUMENTATION

OVERVIEW OF THIS CHAPTER

Introduction

The process of designing a complex system always brings with it the problems of trying to keep descriptive paperwork from lagging hopelessly behind design solutions. Because of the nature of the Learning-Reference System design project, it was particularly important that we have documentation keep pace as the design evolved.

Consequently as a major task in this project we made a concerted effort to work out explicit procedures and formal communication arrangements not only for keeping project documentation parallel to design work but also for consistently carrying through modifications in the plans.

The set of procedures, guidelines and special aids that were developed to make documentation and updating systematic and current is known as the Documentation-Updating System. It is considered part of the larger body of data developed about Information Mapping and its application.

This Chapter

This chapter outlines briefly the nature of the system and describes how documenting and updating procedures are organized.

NEED FOR DOCUMENTING DURING DESIGN DEVELOPMENT

Introduction

To design a computer-based system for learning and reference, we realized, would be a complex and tedious process, extending over many months. These and a number of other factors in the design project made concurrent documentation especially important.

Some Relevant Factors

Initially certain calculations about the course of the design project made us appreciate the need for documentation:

- Designs of complex systems evolve in cycles of successive approximations and even though this was to be a first-pass version, we knew it would change continuously
  - during this project itself, and
  - perhaps over a several year period.
- The information to be developed would be complex, full of small details intricately interrelated and therefore outside the range of ready recall.
- The design would be the work of four or five staff members, each with his own area of responsibility, who needed to share solutions and plans at a very current level if they were not to work at cross purposes to one another.
- The possibility existed that some staff might be dispersed at other locations in the country.
- There was also the probability of some personnel turnover, especially among support personnel.
- There was the likelihood that there might be a lag of several years between design of the system and the beginning of its implementation.
- Those who would carry out the implementation would probably not be those who created the system.

THE NATURE OF THE DOCUMENTATION-UPDATING SYSTEM

Introduction

The development of a set of organized procedures, policies and aids for documentation was an integral part of the present project and early in the first chapter it was mentioned as the fourth major task.

Its rationale and key ideas were worked out even before the design project got under way; its procedures and policies were developed, tried out on the design project and improved through try-and-revise cycles.

General Objectives

Our objective was to develop a system that would encourage the production of documentation at such a level of detail and in such an accessible and understandable form that it would serve:

- the creators of a system during the design process
- designers who are responsible for adapting a system design for implementation in a given facility
- programmers who must translate a design into operational programs
- those who eventually assume responsibility for operating the system
- system managers who in later years must consider the feasibility of modifying or adding major system functions or of adapting existing functions to new equipment.

The Main Features

The central ideas of the system are that:

- Documents are written and organized in Information-Mapped form.
- They are maintained and updated according to explicit standardized procedures and policies.
- The personnel who perform the work communicate with project staff through special record forms that serve as explicit information-channelling instructions.

These topics will be considered separately.

Comment

The system that we describe is still evolving--it improves and expands as our experience with different situations grows. Ultimately, it is expected to become an <u>automated</u> system for document maintenance.

DOCUMENTATION IN INFORMATION-MAP FORM

Introduction

The key idea of the system is that Information Mapping is the basis for all document preparation and organization.

This means that documents are kept systematically in a form that facilitates scanning and retrieval. And, because maps are movable modules, documents can easily be expanded without upsetting the organizational scheme.

Writing Documents

The information that forms the backbone of project documents must come from the creators of the system, and yet these are often the people from whom it is hardest to extract systematic information. Commonly we find that:

- The thinking of creative people runs far ahead of their written output.
- They find the task of writing down their ideas in detail intolerably burdensome.
- They do frequently write themselves cryptic scribbled notes about an idea or possible future plan.

Information Mapping applied to the documentation task will not solve the problem of extracting information from designers, but it has developed procedures that relieve them of some of the more burdensome aspects of the job. It even finds a place for their scribbled notes to themselves so that the system does not risk losing an important idea.

Whether system designers can do their own documenting or must work with technical writers who can elaborate their notes or conversations into formal documents, the aids that Information Mapping can offer are these:

- explicit procedures that enable support personnel to take over the burdensome aspects of document handling
- a set of guidelines and procedures for writing documents in standardized, organized form.

The kinds of procedures that are carried out to keep documents properly ordered, organized, and updated are described in the following map.

For the writers of documents, Information Mapping provides a ready-made set of instructions and guidelines. These were described briefly in Chapter 2 and are given in detail in the manual, A Reference Collection of Rules and Guidelines for Writing Information-Mapped Materials (cited in Chapter 1).

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Use of Decision Tables	In connection with both the design and documentation of computer software, we find decision tables especially useful in that, compared with flow charts, they are: . faster to construct . more efficient in format for verifying logic . easier to revise. Since we chose to build the sequence generator on decision tables because of their flexibility, our system contains many procedures that enable tables to be constructed and revised by support personnel who need have no understanding of the system.
Physical Organization of Documents	The organization scheme for project documents will follow the nature of the project and must be worked out on an individual basis, although commonly it proceeds from general descriptive material about purposes, specifications and major components toward increasingly fine detail concerning each aspect. In our own application of the system, documentation is kept in loose-leaf books because of the frequency with which maps are added or modified. Each member of the project staff has his own copy of the documents.

STANDARDIZED MAINTENANCE AND UPDATING PROCEDURES

Introduction

Maintenance and updating tasks are simple and utterly tedious. Their successful accomplishment depends upon making detailed step-by-step instructions covering what must be done for each situation.

The set of procedures and policies that we evolved are carried out by support personnel manipulating reams of paper, but clearly the same procedures could be carried out on-line, eliminating some of the paper and most of the tediousness of the human tasks.

Description

The full account of the existing procedures and special aids appears in Section 800 of the Project Document cited, Chapter 1.

In general the procedures, rules and instructions described there consist of:

- instructions for adding, deleting, and modifying numerous aspects of the documents--maps, tables, sections, terms, and so on
- instructions for carrying changes through to all areas affected by the modification
- special aids such as tables, lists, questionnaires, record forms and so forth that are intended to streamline staffwork in applying the procedures
- formatting and typing policies made explicit for typists and editors
- various features to keep system designers informed of changes.

While the contents of many of these procedures are specific to the individual project, the principles and general policies are readily adaptable to other situations.

The Next Maps

Rather than attempt to describe each of the above classes of materials, we give a series of examples that illustrate something of the nature of the system. (The actual procedures are given in the Project Document mentioned above.)

DOCUMENTATION SYSTEM EXAMPLE: PARTIAL TABLE OF CONTENTS, UPDATING SYSTEM

Introduction

This sample from the Table of Contents of the Updating Procedures Section is reproduced here to show the kinds of tasks that must be made explicit.

End of example

125

DOCUMENTATION SYSTEM EXAMPLE: STARTING POINTS FOR UPDATING ORDERS

Introduction

Orders to change documentation come to an updating assistant. The table below shows him where to start in processing such orders.

The nature of the change is located in the first two columns, the appropriate starting map for each is shown in the righthand column. These latter maps contain decision points that lead to other procedural maps within the system, thus insuring that the entire document is properly updated.

ORDER	ITEM REVISED	WHERE TO START
Index	. any term . any map	HOW TO INDEX TERMS, 800/63500
	Section of the document which does not contain decision tables	HOW TO INDEX A SECTION OF THE DOCUMENT, 800/63250
	Revised map	HOW TO UPDATE THE INDEX FROM A CHANGED MAP, 800/66600
	Revised Decision Table	HOW TO UPDATE THE INDEX FROM A CHANGED DECISION TABLE, 800/66800
Change	. name of a term	HOW TO USE THE INDEX TO CHANGE THE NAME OF A TERM, 800/63600
Add	Map	HOW TO ADD A MAP, 800/56000
	Section	HOW TO INSERT A NEW SECTION, 800/43000
	Flag	HOW TO ADD A FLAG, 800/71000
	Variable	HOW TO ADD A VARIABLE, 800/72000
	Switch	HOW TO ADD A SWITCH, 800/73000
	Command	HOW TO ADD A COMMAND, 800/74000
	Decision Table	HOW TO ADD A DECISION TABLE, 800/75000

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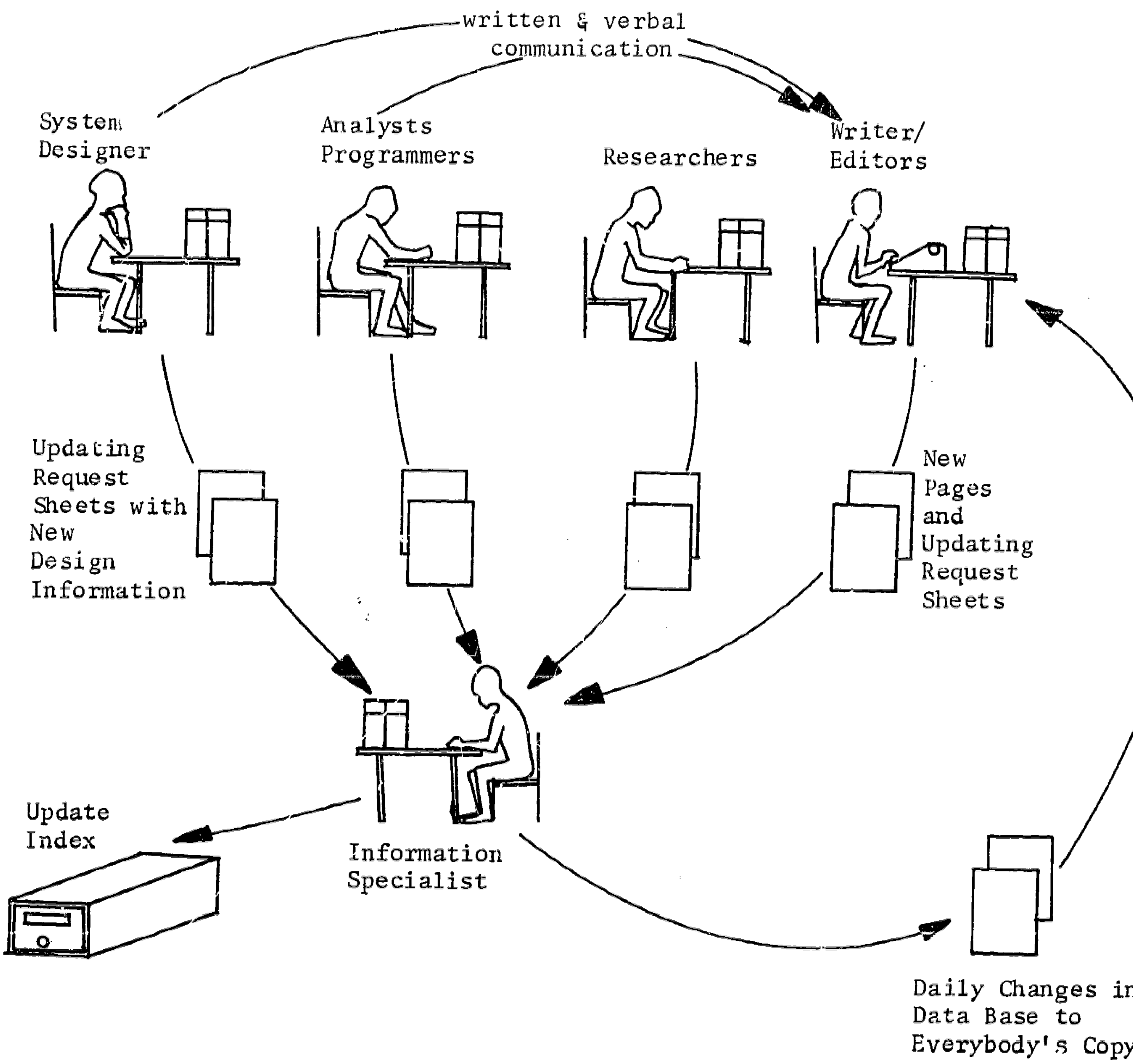
DOCUMENTATION SYSTEM EXAMPLE: STARTING POINT FOR UPDATING ORDERS, continued

ORDER	ITEM REVISED	WHERE TO START
Add (cont)	Attribute	HOW TO ADD AN ATTRIBUTE, 800/76000
	Term	HOW TO ADD TERMS TO THE INDEX, 800/16000
Date and/or Number	• any item	HOW TO DATE A MAP, 800/52000
		HOW TO NUMBER A MAP, 800/51000
Update	WHICH TABLES MENTION OTHER TABLES map	HOW TO UPDATE THE "WHICH TABLES MENTION OTHER TABLES" MAP, 800/68600
	WHERE EACH TABLE IS REFERRED TO IN THE OTHER TABLES map	HOW TO UPDATE THE "WHERE EACH TABLE IS REFERRED TO IN THE OTHER TABLES" MAP, 800/68800
	WHERE EACH FLAG IS MENTIONED map	HOW TO UPDATE THE "WHERE EACH FLAG IS MEN-TIONED" MAP, 800/68200
	WHERE EACH SWITCH IS REFERRED TO IN THE TABLES map	HOW TO UPDATE THE "WHERE EACH SWITCH IS REFERRED TO IN THE TABLES" MAP, 800/68400
	All copies of the document	THE "WHAT IS NEW" FUNCTION, 800/83800
	Table of Contents	HOW TO MODIFY THE TABLE OF CONTENTS, 800/24000
Delete	Section	HOW TO DELETE A SECTION, 800/42000
	Map	HOW TO DELETE A MAP, 800/57000
	Terms	HOW TO DELETE TERMS FROM THE INDEX, 800/64300

DOCUMENTATION SYSTEM EXAMPLE: MISCELLANEOUS AIDS

Status Remark Sheet	The Status Remark Sheet record form provides a means for a system designer to communicate about changes he wants made, future plans, points of disagreement on some aspect of the system. It may be addressed to specific staff members or to the project director, but in any case it will go through a central clearing point.
Request for Clarification Sheet	The Request for Clarification Sheet is a standard form by means of which questions on some aspect of the system may be routed to the appropriate person. It may be used by all project personnel and it is always routed through the updating assistant who keeps track of pending questions.
"What's New" Service	All principal staff members have copies of all project documents which are kept up-to-date by support personnel. All receive lists of changes that have been entered, but there remains the problem of calling their attention to significant changes. Special periodical summaries are issued to take care of this.
Short Courses	Selections from the documentation of various policies, procedures and formats are easily assembled into self-instructional courses for typists, clerks, writers, programmers and the like. By this means we have found it economically feasible to employ temporary personnel. The existence of such explicit base materials also has minimized project slowdowns due to personnel turnover.

SKETCH OF DAILY DOCUMENTATION ACTIVITIES DURING SYSTEM DESIGN



129

DOCUMENTATION POLICIES

Introduction

Any program for documentation will work only so long as it has:

- top management support
- clearly drawn lines of decision-making authority and of responsibility for approving document entries
- an established list of priorities for accomplishing the various classes of tasks.

Management Support

If documentation is to be accurate and complete on the one hand, and useful to the community of creators on the other, it must begin when the design phase begins.

Too often documentation is the final mopping-up task after the project has been finished, ideas have grown cold, and staff has grown impatient to turn to other things. Documents could hardly fail to be superficial and incomplete.

To get good documentation, top management must support it seriously with a top priority rating and sufficient funding. They must also recognize its role as an important tool throughout the actual design process.

If documents are begun at once, made easily accessible, and kept current, designers will derive much help from them. In complex projects a designer cannot keep in mind all the consequences of a modification he makes even in his own area, let alone the effects it might have on the work of others. But system documents with lists that track each idea to all references in the system let a designer see ramifications of a change that he could not otherwise appreciate.

Thus documentation must be perceived by management not as constituting the final straw at the end of a long project but as playing a vital role in the design process from the beginning.

Priorities and Responsibilities

Documentation can become a morass unless explicit policies are formulated to control the movement of materials in and out. The statement of such policies, lines of authority and lists of priorities should be worked out by project managers before documentation begins.

Periodic reviews should be slated to examine the efficiency of the procedures and to revise them when necessary.

SUMMARY

Emphases	The Documentation-Updating System is based upon these convictions: • documentation should begin when design work begins • documentation, properly executed, is an important tool <u>during</u> the design process • change must be taken for granted and planned for • documenting and updating procedures can be made so explicit that consistent actions are taken and changes followed through • functions involved in documenting can be effectively separated and assigned to specialists in such a way that system creators are spared the more burdensome aspects • documentation needs significant management support.
Basis	Information Mapping is well suited as the basis for documentation because: • its formatting and reference features facilitate scanning and information retrieval • its modular form permits documents to be expanded and modified without upsetting the organizational structure.
The System	The Documentation-Updating System consists of: • a set of procedures for writing and organizing documents in Information Mapped form • a set of standardized procedures and policies for maintaining and updating the documents.

CHAPTER 7 SUMMARY OF THE LEARNING-REFERENCE SYSTEM

OBJECTIVES OF THE SYSTEM

Chapter Preview

Previous chapters have sketched in the main features of the Learning-Reference System. Since we have talked of many things the system can do and of the many mechanisms it uses, we propose in this chapter to draw it all together in a quick recapitulation of what the system does.

This summary may be a convenient reference aid in later discussions of assessment and future plans.

Primary Objectives

The primary objectives of this system are to provide computer-based information services for:

- initial learners: the service to consist of sequences of information displays that are either chosen by the learner himself or that are recommended for him by the system after evaluating:
  - his goal in learning and the level of mastery he seeks
  - his background experiences, abilities, and attitudes
  - his behavior and preferences shown during learning sessions.
- reviewers: the service to consist of the following aids to the person who wants to refresh his memory:
  - evaluation of his knowledge of the area
  - an individualized, guided review of those materials that he has forgotten or wishes to see
  - sequences for relearning either under system control or under the user's own direction.
- reference users: the service to consist of aids to enable the user to identify quickly the information he needs and to call it up for display.
- briefings: the service to consist of displays of information about any specified course, giving the client an overview of the course, its aims and requirements.
- browsing: the service to consist of aids to enable browsers to move about in any manner they like.

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Secondary Objectives	The secondary objectives are to build into the system those support services that will make it easy: . to prepare information materials . to collect performance data on system functions and on information units for the purpose of guiding continued improvement of the system . to update information units . to modify system functioning . to collect for research purposes various data about system functions, information usage and clients' behavior patterns.

MAIN SYSTEM COMPONENTS AND THE FUNCTIONS THEY ACCOMPLISH

1 Modular Information Base	The contents of the information base may be characterized as follows: . written <u>subject-matter materials</u> are classified by Information Mapping categories and are stored in labelled information blocks that can be individually called up and displayed as required by each client . complete <u>descriptive details</u> about the information blocks and their various groupings into maps, units, and courses are stored in the data base in order to permit selection of materials suitable for the individual client . <u>data about the clients</u> are maintained in order to make possible delivery of information sequences that are responsive to their needs. The data may include: . purpose of user and level of mastery sought . previous experiences, abilities, attitudes . performance on prerequisite tests and pretests . switch settings that determine how the client and sequence generator will interact . various flags, lists, etc., that keep track of the flow of action during each client session so that meaningful sequences are displayed. . <u>data about system components</u> are stored to enable the sequence generator to accomplish various system functions such as reacting to commands.
2 Command Language	The command language consists of a set of terms designed to enable the user to direct the computer and to respond to displays. The set is capable of being restricted for some classes of users.
3 The Sequence Generator	The sequence generator is a computer program based upon a set of decision tables that handle all transactions between users and the information base. It not only fetches information for display but also keeps records of the interactions. The generator has the capability of responding in the ways described below, but not all clients will be allowed to take advantage of them.

continued on next page

134

(continued) 3 The Sequence Generator

The generator operates in different modes depending on the user's purpose:

. Initial Learner Mode:

- for each learner a learning goal is established in terms of how much of the subject matter he wants to cover
- for each learner a criterion is established also to indicate how well the learner wants to know the materials
- control of information selection and arrangement can be allocated to user or to system or it may be distributed between them in various patterns
- level of control can be designated either by the user himself or by a supervisor, depending on how the computer facility is managed
- the learner with freedom to control the system can use all commands and learner services of the system; he can take charge of his own learning path or he can direct the generator to take some control over the sequencing just as it would for learners with less freedom in the system
- when the generator takes part in sequencing decisions, it takes into account many aspects of stored data about the learner
- sequencing also depends partly on the learner's responses to feedback questions and to unit pretests
- feedback to learner may be given or withheld at the discretion of the learner himself or of a training supervisor
- the selection of feedback questions or worked examples for display may be based on their ratings in terms of difficulty level
- remedial sequences may be presented when a specified failure rate is reached on feedback questions
- a learner may change the standard order in which blocks are displayed to him and he may add other blocks to the standard pattern
- the learner may ask to see additional blocks about a topic or to try extra feedback questions

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3
The Sequence Generator

- the learner may depart from a sequence to revisit a previous map and may then return to his place
- the learner may select the next topic from a list of appropriate maps
- the learner may ask the generator to explain the meaning of commands or to suggest appropriate commands he might use next
- the learner may enter comments about the materials, some aspect of the system, or his reactions to it; later these are reviewed by the supervisor or course designer.

- Reviewer Mode:
  - control of information sequencing can be allocated to the reviewer, to the generator, or to both in a more or less equal distribution
  - in the system-dominant condition sequencing depends upon the user's responses to review questions at the unit level
  - units that are passed at a specified level drop out of the guided review sequences
  - users in the guided review condition require little knowledge of the command language
  - reviewers in the freer control conditions may take pretests in order to bypass units whose material they already know
  - reviewers in the freer conditions may review the course materials as they wish, including calling on the generator to take over routine sequencing tasks
  - reviewers may ask for feedback questions and may have their answers judged, but these do not affect the sequencing decisions.

- Referencer Mode:
  - the user is allowed complete freedom to use the system's facilities as he sees fit
  - four simple commands enable the untrained user to find what he wants: Table of Contents command, Index command, Goto command, and Change Course command

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(continued) 3 The Sequence Generator

- system will instruct the user if inappropriate commands are used or if help is requested
- the user may respond to feedback questions if he likes and may ask to have his answers evaluated.

- Briefing Mode:
  - special materials give the client an overview of the content and structure of any specified course; the displays, under the control of either the system or the user, include:
    - course objectives
    - main points of the course
    - difficulty levels and prerequisites
    - applications
    - sample lessons
    - number of maps and estimates of time to learn.
  - those who come to the system for information about the general nature of course materials select whatever kinds of information they want or they can ask the system to present briefing materials to them
  - those using the briefing mode can set a limit to the amount of time they wish to spend and as a consequence the generator may reduce coverage of less important aspects
  - the mode permits comparison of two courses across significant dimensions.

- Browsing Mode:
  - the design of this mode is not yet complete, but its aim is to help the browser explore as he wishes; it will probably be built upon many of the mechanisms of the Referencer Mode except that the browser's freedom will extend across courses.

Supplementary Services of the System

The system also supplies support services, including:

- complete writing guide for the preparation of Information Mapped materials, including questionnaires to guide authors in recording descriptive data required by the sequence generator
- system documentation in Information Mapped form giving easy access to all aspects of the system
- written manual of step-by-step procedures for preparing system documentation and for maintaining it in up-to-date condition

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(continued) Supplementary Services of the System	• a "What is New" service to notify all system personnel of recent changes in the system and to call attention to significant differences • a computer-directed interview with the training supervisor to elicit from him the information that defines how much guidance the generator is to give each client • procedures for collecting statistics across courses and across users • printouts of data summaries to aid researchers and training supervisors • procedures and standard forms by which system personnel such as designers, editors, or programmers communicate about the changes they want to make • special sets of tables to aid designers, programmers, and updating clerks by providing lists of system components and of the places where each of them is mentioned in system documents • short training courses for support personnel.
Comment	Certain plans for possible extensions and modifications of these functions in a later version are mentioned in the closing chapter.

CHAPTER 8 EVALUATION OF THE SYSTEM DESIGN

WHY EVALUATE

Introduction

At various stages in a project it is customary to make an evaluation of one sort or another. In what sense could we evaluate the design for a system? We remind ourselves that evaluation is essentially a judgmental process and that it is by no means synonymous with statistical assessment of quantitative data.

Whether quantitative data are appropriate for the judging process depends entirely on the nature of the situation and the purpose for which evaluation is to be made.

The evaluation of a paper plan differs considerably from the evaluation of an operating system or of an educational program. In the latter cases, performance data, user surveys and the like can add an agreeable air of objectivity to the decision-making process. With a paper plan, we have to muster other kinds of information to aid in judgment.

Let us consider first why we would want to attach a value to a plan--that is, what would be the purpose of evaluation at this stage. Then we can see what kinds of information would be useful for the task.

Purpose

The purpose of evaluation at the design stage is to reach a decision about the project's future--whether to build the system essentially as proposed, cancel the project, or revise the plan and then reconsider its future.

Such a decision involves considering these two classes of questions:

1. Those concerned with its functions and the mechanisms for accomplishing them: Does it do the kinds of things we want? Is there some better way of doing the various functions? Are there places where we would prefer some other alternatives?

2. Those concerned with its costs: What will it cost to implement at several different levels from deluxe, say, to a stripped-down version? How much will it cost to maintain it, make new course materials for it, train personnel for it, and so on?

Comment

The problem of assembling information that bears on these questions will be considered on following maps.

THE QUESTION OF OFF-LINE SIMULATION

Introduction

Since we can get no real performance data from the system, we considered the possibility of using the simulation approach to try out aspects of system functioning.

Commonly when a real system is not yet in existence, some form of physical or symbolic model is constructed to simulate aspects of the system design in such a way that they can be tested. The purpose of course is to gather information that will help in finally implementing the system.

Models vary greatly--some are mathematical formulations subjected to computer manipulation, others are descriptive models subjected to logical analyses, and still others are actual physical prototypes that are subjected to real-time use by real people.

Possible Results From Simulation

In the earliest stage of the design process, we had conjectured that useful data might be obtainable by asking human operators to mimic the actions of the sequence generator and thus select paper displays of information blocks; the sequences might even be used by tryout subjects for learning or for reference work.

In actual fact, however, the sequence generator evolved into a much more versatile and complex program than we had anticipated. It was quite clear that its functions were dependent on too many details to be simulated by hand. In selecting information sequences, the generator has to check the status of so many computer locations and to consult and/or modify so many flags, switches, lists, stacks and so on that a hand-operated simulation could have no hope of producing displays with any useful frequency. Real subjects would perish from boredom between displays; thus no relevant information could emerge from such tryouts.

As a matter of fact a team of staff members did experiment with stepping through the programs and decision tables of the sequence generator to assemble paper "displays." The objective was to see if we could speed up our hand-operated simulation enough to warrant data collection with real subjects. Even with practice and shortcuts, the process remained unrealistically slow; we found that those parts of the sequence generator that we were using did "work" in the sense that they led to the delivery of meaningful sequences, but we discarded the hope of trying real learners or reference workers with it.

Without real test subjects, the only conceivable utility of continuing such an exercise would have been to check the linkage between program elements; that however is a trivial task better done by the routine desk-checking procedures of the computer-programming field.

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(continued) Possible Results From Simulation

Apart from the question of system functioning there is the question of whether a simulation of some sort could test the adequacy of the Information Mapped data base--that is, whether the different possible arrangements of blocks drawn from the information base make sense and are acceptable to the different classes of users.

We already had a collection of blocks cut from the Information Mapped book on Sets and individually mounted on index cards. These were useful for testing the adequacy of our guidelines for preparing course materials for the proposed system.

Now would a simulation using this collection of information blocks with tryout subjects help us in assessing the meaningfulness of reassembled information blocks? We think not--it would tell us something about the specific product, the book on Sets, and it might detect the need for a change in the writing rules. But shortcomings in either case would be corrected in routine developmental testing.

Conclusion

At this stage of the design, it is not possible to produce quantitative evidence bearing on its effectiveness. We do, however, argue that:

- the basic conceptions underlying the system have been subjected to repeated logical analyses by us and their soundness may be tested independently by anyone who wants to examine the detailed system plan.
- all components of the system, including information base organization and sequence generator details, are so designed that they can easily be improved according to procedures that have already been specified.

In short, the effectiveness of the proposed system can best be judged by experts who study the project documents. And there is the added assurance that a specified quality level is achievable through the built-in provisions for developmental testing and revision.

Apart from the question of effectiveness, however, other aspects of the system must be considered in reaching a decision about its future. These aspects are discussed on the next map.

BASIS FOR EVALUATION

Introduction

Whether a system has value for a given client depends upon whether it supplies the services he needs at a price he can afford.

Some of the questions that one would ask in order to judge the Learning-Reference System are:

- Does it provide the services you want for your clientele?
- What tasks would be required to implement this system?
- How long would it take?
- What range of costs might be associated with different versions of the system?
- What is required to operate a system like this?

Information concerning each of these will be considered.

Services

Only a prospective client can judge whether the system provides the range of services he wants. In the case of the Learning-Reference System, he can ascertain that fact by comparing his requirements with some statement of the characteristics of the system. The material in Chapter 7 may be a convenient source; if the summary statements seem promising, the prospective client would want to follow up by study of the system documents.

Preparation of Course Materials

For the Learning-Reference System, the tasks required for producing course materials are much the same as for producing mapped books. However, there is also the work of storing extra examples and feedback questions, and of recording details about the materials for the sequence generator's use.

In 1969 (Horn, Nicol, Kleinman, Grace) when the tasks and costs of Information Mapping books were estimated, we judged that the time spent on the major tasks of production was distributed this way:

. curriculum planning	25%
. writing and editing	55%
. developmental testing	20%

The direct labor cost for materials sufficient for an instruction hour was estimated to run around $1000. (Organizational overheads are not included and may run up to 150% of direct labor.)

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(continued) Preparation of Course Materials	Materials for the computer-based system can be expected to cost more since the writing tasks are somewhat greater. In view of the extra work and rising costs, our best guess now is that the materials for an hour of instruction would run in the neighborhood of $1500 (direct labor cost). Materials for an hour of instruction have been used as the basis for the estimates because they constitute the major writing chore for the information bases of the Learning-Reference System. It should be remembered, however, that these materials serve other purposes as well. Strictly speaking, then, we should point out that the cost estimates are for an hour of materials for instruction, reference, review, and briefing. The cost of preparing materials can probably be reduced if the work is broken down into separate functions and each assigned to a specialist. For example, the initial writing can be done by the subject-matter expert; the draft can be turned into Information Mapping form by a mapping specialist; support personnel can record the attribute data about the materials in the form required by the computer, and so on. We are experimenting with this procedure now but have no cost data available for comparison.
Training Writers	The above figures do not include the costs of training writers. Our experience in training for Information Mapping suggests that a one-week course followed by several weeks of practical experience under a competent editor is sufficient. The Learning-Reference System documentation includes formal questionnaires that quickly draw from writers the exact information about the materials that the system requires. Other procedures and checklists aid in streamlining the writers' work and reduce training time.
System Design and Programming	The selection of a computer system will involve consideration of many aspects of the clients' needs and resources. Once that decision is reached, system design work will be required in order to adapt the Learning-Reference System to the facilities and software of the chosen computer. This involves the working out of file management procedures, data base formats, data collection procedures and the final decision concerning what sequence generator details are to be implemented.

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(continued) System Design and Programming	Programming, coding, and debugging the sequence generator come next. Course materials must be translated from paper to the computer data base. And finally a period of system integration, checkout and revision will be needed. The amount of work involved in each of these tasks will vary with the sophistication of the system and its ready-made facilities.
Time and Costs	The time and cost of implementing the Learning-Reference System will depend upon how elaborate the system is to be and how many users it is to serve simultaneously. One system might incorporate all the major functions of the design but minimize the number of desirable-but-not-necessary services. Another system might include not only the major and secondary functions of the design but also automation of support functions such as supervising and updating. Since the possible configurations of computer facilities and versions of the Learning-Reference System are endless, the only way we can say something useful about time and cost figures is to take representative examples of a large system and a small one and try to make estimates for them: System I . Educational/training objectives primary . Limited version of sequence generator . One course available at a given time for the multiple purposes of 1 to 6 users . Small computer in the \$50,000-\$70,000 class with adequate time-sharing, display, and file management packages Cost to implement: \$50-75,000 (direct labor cost) Time required: 12 months (Cost of course materials and computer time for system development not included.) System II . Information management as primary concern--training objectives, secondary . Expanded version of sequence generator . Up to six courses available at one time for the multiple purposes of 1 to 100 users . Large general purpose computer facility with adequate time-sharing, display and file management packages. Cost to implement: \$100-150,000 (direct labor cost) Time required: 30 months (Cost of course materials and computer time for system development not included.)

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Operating the System

What is involved in the day-to-day operation of a Learning-Reference System? Although the number of support personnel will vary with the size and complexity of the installation, we can identify the functions that will have to be carried out to keep the system operating efficiently:

- managing: deciding facility policies, assigning support personnel, scheduling system operations (on-line time for primary and secondary users, and for maintenance technicians), establishing priorities for support personnel
- programming: system modification, loading of new course materials, correction of stored course materials, improvement of data collection procedures, and so on
- updating and documenting: insertion of all changes required by revision of course materials and additions to system documentation
- supervising: deciding the kinds of guidance the sequence generator is to provide for each client, entering starting data for each client into the system, evaluating performance data in order to guide initial learners more appropriately (optional)
- research: collection of performance data concerning system functions, information block use and user behavior patterns; evaluation of course materials; comparison of conditions; recommendation of changes.

In a small educational facility these functions might be carried out by a staff of two or three, while in a large facility each function might require several people. (Personnel required for the preparation of course materials were discussed in an earlier block.)

CHAPTER 9 FINAL CONSIDERATIONS AND SUMMARY

OVERVIEW OF THIS CHAPTER

Introduction	The major features of the Learning-Reference System have been charted in fairly detailed form, but the plan is only the springboard for the future. Even as the first version evolved, ideas for later versions were being recorded. Several generations of the system can already be dimly perceived.
This Chapter	In the next few maps, plans for later expansions will be mentioned. Finally we shall return to consider the immediate utility and importance of the present version and the research contributions to be expected from its implementation.

Introduction

In the first version of this system, a number of desirable features were left out because we were concentrating on developing the main mechanisms that would move the information blocks around and that would control interactions with the user in various ways.

Some important features were left out also because their design depended too much on the capabilities of the specific computer that may be involved.

Now the possibilities for incorporating such features may be considered. Some have already been mentioned under "Limitations of This Version" (Chapter 1) as being desirable next steps.

Display

The most important addition to the system will be the programs that determine how display capabilities of the given computer will be utilized in the Learning-Reference System.

It would have a tremendous impact on the system, for instance, if the display scopes could be used as a response medium. If area or marginal displays could be generated independently of the main information block displays, then such aspects as these could be shown:

- possible next topics
- permissible commands
- local index for related topics
- prompting comments.

The users could indicate many of their commands and selections by means of the light pen rather than by keyboard. This would probably make it much easier for the user to learn to operate the system.

The parameters of displays that can be manipulated during a session (brightness, size of characters, formats, etc.) will have to come under control of either the system or the user. New dimensions for controlling these will have to be defined and implemented in decision tables.

Various display options can be used to increase the impact of information-block materials. It is the author or curriculum specialist who would call upon these. For example, diagrams or sketches can appear in one area to illustrate the concepts or processes being explained by the information block in another area. Tables and diagrams might be revealed only a

continued on next page

(continued) Display

part at a time as the text explains each. Structures can be "exploded" or "imploded" to show how parts fit together, and so on. The whole area of graphics technology can be drawn upon for ways to improve displays.

The role of animation as an educational tool has been explored in films and TV, but not enough is known about it yet in the computer setting. Animation techniques could be applied to highlight important points, focus attention, illustrate movement in networks, processes and the like. The impact of such techniques will undoubtedly vary with the individual differences in users and will have to be studied in controlled research.

If computer-display capabilities are to be put to practical use in improving the communication value of instructional materials, then the system must be prepared with supporting programs that will enable authors and designers to use the display options without the need for special training.

Sequencing and Control Decisions

Often through this report we have mentioned our intention to eliminate the supervisor from the system eventually. It is probably not wise to plan for this until after a period of experience with an operating system. While many of the supervisor's functions have already been marked for automation and could easily be turned over now, there are still other aspects of a new system taking to the air for the first time that require feedback from a knowledgeable observer. Whether that person be a training supervisor or researcher is not important at the moment, but it does appear that a period of shakedown experience should precede an attempt to formulate the algorithms to do the supervisor's work.

The expansion of dynamic sequencing decisions made during the sessions is another aim for future system versions. The system could be made more responsive to the individual if it had more opportunities for reacting to user behavior patterns and performance data as each session unfolds.

The definition of what aspects should be evaluated on a continuing basis and how they should influence sequencing decisions can also probably take place most efficiently after an operational version of the system becomes available. Study of interaction records and real user data would help in evaluating the feasibility of various alternatives.

At any rate, an on-going objective of the system should be to continue to improve its responsiveness to the individuality of its users.

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Inclusion of Common Computer Capabilities

Computers commonly possess routine capabilities that the present version does not utilize. It has been our intention to make them a part of the services of the Learning-Reference System but their inclusion must wait until a specific computer has been selected.

The remarkable power of the computer to perform on-line computations should be put at the disposal of the users of the Learning-Reference System. To be able to switch from an instructional mode to a computing mode is an exciting possibility for those who are learning or consulting mathematical or engineering materials. The motivational aspects alone of being able to do real work with a big computer system are incalculable.

The power of a computer with display capacity to aid in practical design problems--whether it be circuitry design or architectural design--might also be available for the users of some systems. Dynamic display options plus the capacity to "draw" or "write" on the scopes could enable the users to create and experiment in unpredictable ways.

These features cannot be added to the design of our system in any useful way until more is known about the memory capacity and display capabilities of the specific computer it is to use.

The printout capabilities of a computer system can also be considered an important educational resource. As we mentioned at the end of Chapter 1, there may be economical problems in controlling its use. Nevertheless, to allow system users to take home materials for review or reference may actually result in on-line time savings.

The Learning-Reference System will have to add the programs to control such printouts and to enable system clients to specify what they want and how it should be formatted.

Computers are able to tell time in remarkably small increments. This inherent capacity can be used in many ways which our system design does not include yet. The Briefing Mode, for instance, plans to adjust its presentations to clients according to the amount of time they want to spend. This needs implementation.

Evidence of varying quality suggests that time pressures may actually facilitate the learning of certain types of individuals. Time limitations on tests may be sometimes desirable as well. Time spent on maps, feedback questions and the like is useful evidence to guide revisions of materials.

Later versions of the Learning-Reference System, then, should include programs to deal with time controls and time recording.

LATER VERSIONS

Introduction

Among our dreams of second or third generation Learning-Reference Systems, we see a growing sophistication in the inclusion of other media under computer control. We also see a more effective utilization of the associative capacities of the computer.

Media

Future versions should have richer data bases in the sense that many other media can be controlled and inserted into the user-system interaction by the sequence generator. Among these are:

- printed materials ("hard copy," reproductions, etc.)
- real objects (for illustration, identification, diagnoses, etc.)
- physical models (of the brain, of the telephone, of the snail, etc.)
- sketch pads
- tape recordings
- slide and film projections
- video tapes.

We suspect that an important part of the enjoyment of learning is the unexpected encounter with surprises and humor. We hope that future versions will include a liberal lacing of these ingredients coupled with a subtle appreciation for the proper moment for inserting them.

It is unrealistic to imagine that course designers or authors will make full use of these system capabilities unless the system is ready with programs that will help them with very practical techniques for specifying what they want.

Cross-Course Links

The next version of the system will expand the cross-referencing procedures of the system. At present we have only detailed tables of contents and a cross-referenced index for each course. Greater power, especially for self-directed learners, can be gained by adding linkages across courses. Some provisions might be included to let users comment on some of their own insights about the links.

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Simulation and Games	The mechanisms of the Learning-Reference System are so flexible that games and simulation exercises can be made a part of the learning, referencing, reviewing services. Short courses to teach effective use of the system can be accomplished by games simulating system operations. Earlier we mentioned the desirability of using simulation to start users on the path to self-directed learning. Short exercises, discussions of useful strategies, and hypothetical problems can be combined to work toward that objective. To incorporate such possibilities in a learning system requires considerable work. The feasibility of adding them depends on the specific system's capacity and on the addition of aids to the game designers so that they can easily take advantage of the full range of system capabilities.

Introduction

Organized efforts to advance the efficiency of computer-aided instruction differ in many ways, but one dimension along which they may be distinguished is that of the static or dynamic nature of the information base.

The majority of systems have data bases whose structure is fixed in advance, everything having been entered by the authors, including canned messages and all the remedial branches that can be anticipated. An example is the Air Force's Computer-Directed Training System ("The Development of a Computer-Directed Training Subsystem and Computer Operator Training Material for the Air Force Phase II Base Level System," AD 702-529).

A small but potentially very important line of development lies in the area of artificial intelligence. Exemplified by a system such as Carbonell and Collin's ("Mixed-Initiative Systems for Training and Decision-Aid Applications," ESD-TR-70-373), the data bases of these systems are capable of generating questions and answers not anticipated by the data base writer.

Still in their infancy, these so-called generative systems function through executive programs that can analyze the semantic and syntactic structures of the stored information. They are "knowledgeable" in the sense that they can produce meaningful information not stored *per se* in computer memory.

The possibility of a future union of these diverse approaches intrigues us now.

Future Union

In this context our Learning-Reference System belongs in the class of static or structured data bases from which no new inferences or generalizations can emerge as a result of the master control program.

The extensive nature of our underlying decision structures enables our system to control the conditions of user-system interaction, and to respond to the longer-term histories of system users. This capacity to respond individually to control conditions and to experiment with teaching strategies offers certain present advantages for practical applications and for controlled research into optimum conditions of learning--yet we foresee the day when artificial intelligence capacities and systems such as ours may combine to give us an automated tutor whose memory, intelligence and capacity to discern the individual needs of users far surpass the powers of human teachers.

UNIQUE RESEARCH CAPABILITIES OF THE SYSTEM

Quotation

The most important impact on education of computer technology . . . will probably be by supplying a tool for finding out what we are doing, for turning anecdotal impressionistic answers into scientifically testable ones, and so turning what has been almost purely an art into a respectable science--and without eliminating the artistic aspects either. Research in education, advances in educational understanding, education as a behavioral science will be, I think, the most important outcome.

R. W. Gerard
(Dean of the Graduate Division,
University of California, Irvine)
in Computers and Education, p. xiv,
McGraw-Hill, 1967.

Advantages and Issues

The Learning-Reference System as outlined here would constitute a significant research facility. Its unique capacity to manipulate and control conditions and to keep records makes possible a rigorous research attack on the important unsolved problems of education and training. Conditions can be changed and running records kept not only for the user's response patterns and performance data but also for the frequency patterms of information-block usage and command usage under each experimental condition.

The issue of how much guidance should be given a learner has long concerned educators. Now, as we have seen, this one system can offer varying degrees of guidance ranging all the way from total control of the learner to no guidance of him at all. Research with each learner using the system under systematically varied control conditions would begin to give us some long-sought answers.

But now the issue becomes one not so much of how much to guide the learner but rather how much to guide what kinds of learners. Recent concern with fitting instruction to the individual student points up the need for studying the effect of guidance conditions on various kinds of users, distinguished on the basis of patterns of data stored in their data bases.

Quite apart from the issue of how much control, if any, is best for each individual, there is the problem of prescribing information sequences and response requirements for the various learners or reviewers who are being in some degree guided by the system. In earlier discussions of this topic in Chapters 3 and 4, prescription-making was largely left on the doorstep of the curriculum specialist or author with the assumption that he would know not only what sorts of sequences should be

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(continued) Advantages and Issues

assembled for which kinds of people, but also what kinds of remedial sequences are suitable to each. And we provided him with all sorts of new and old information about each user so that he would have concrete data for making his decision about sequences.

As a matter of fact, no one really knows very much about prescribing for the individual nor about what factors in the short- or long-term history of the person are relevant to such decisions.

One of the most important advantages of the Learning-Reference System is that it is designed to find answers to these problems. It is structured so that sequencing decisions can draw on many aspects of the user's background, interests, objectives, changing behavior within the session, and so on. This capability, coupled with its control over conditions and its record-keeping advantages, offers unprecedented research tools for "learning about learning."

While a major research effort on individualization is a pressing need at the present time, there remain a number of other or related research problems which the Learning-Reference System is equipped to tackle: controlled comparisons of teaching strategies, the effect of feedback variations, motivational effects of different learning conditions, curriculum-materials research, multi-media research, comparison of strategies for improving self-direction, and so on.

The effect of various display parameters not only on learning but on reference and reviewing as well is another fertile research area that can now be explored in relation to individual differences.

While some of the richest research problems center around initial learning, the related topic of reviewing and, by implication, retention, offers some interesting research possibilities--the effects of individualized treatment here also, to mention only one.

In terms of long-run impact, probably the most important aspect of the Learning-Reference System lies in its potential for searching out the answers to the practical problems of making information services more effective.

IMMEDIATE PRACTICAL USE OF THE SYSTEM

Introduction	The present system marks an important step toward making the computer a practical force in education and training. It can guide the user or free him to use the information base as he wishes. It can deliver sequences for him that take into account his short-term and long-term history and that reflect a given teaching strategy. It can make available to him the facilities of a major computing system--to compute, to design, to cross-link, to create, to learn, to browse, to experiment, to explore.
Present Outcomes	Immediate practical outcomes for training and job aids can be expected from the implementation of this system plan on an existing computer--yet implementation is also important for the further evolution and refinement of this system. It is only by practical experience that the validity of certain solutions and the feasibility of some features can be tested. Through the experience of operating such a system and of receiving feedback from its users, more subtle decision rules can be formulated. Systematic observation of system users and study of their data and comments can lead to the devising of more useful aids for referencers, reviewers, and other users whose needs are not so clearly recognized now. Cycles of developmental testing and revision are required to improve not only the information materials of the system but the operation of system functions as well. These are the necessary sequels of implementation on an operating system.

Concluding Statement

The computer-based system we have designed will provide information services for a variety of users who need access to textual materials: learners, reviewers, referencers, browsers, and so on. The quick retrieval of relevant information is achieved by having materials sorted into blocks and labelled according to the class of information concerned. Information Mapping is the name given to the unique classification scheme that guides this basic organization of information; it also includes formatting rules and guidelines for effective display.

The computer-controlled system is so designed that users can explore the information base of organized, labelled blocks with the same freedom they exercise in a library. But for those who need guidance, the system can enter into the process of selecting and assembling those blocks that are relevant to the user's objective.

The system's role in information sequencing can vary from minor prompting all the way to total control of pacing a user through a subject matter to achieve a specific instructional goal.

Whenever the system enters into the process of assembling information for display, it is set up to take into account the individual user's needs, capabilities, interests and the like.

While it is now possible to make reasonable prescriptions for information sequences suited to certain individual differences, (a neophyte in mathematics will obviously not be shown the same displays as the college senior math major), there remain many gaps where research evidence in education and psychology simply does not exist to guide sequencing prescriptions.

The present system is designed with the flexibility not only to incorporate new research findings into the decision-making mechanisms but also to take an active role in gathering under controlled conditions the comparative data that will extend our knowledge of how to make information presentations more effective for each individual.

APPENDIX A

Introduction

The Information Map Classification Chart (in updated form) is reproduced here from a previous report, Information Mapping for Learning and Reference. Horn, Nicol, Kleinman and Grace, ESD-TR-69-296.

MAP CLASSIFICATION CHART

Types of Maps	Description	Information Blocks
Concepts	A concept may be a: . technical term . generalization sentence . property sentence . rule sentence . relationship sentence	. name of the concept . definition or description . theorem (or generalization) . formula . use . rule . example . non-example . introduction . synonym . notation . diagram . comment . analogy . related maps

Structures	A structure is:
	. a physical thing, or
	. something which can be divided into parts which have boundaries.
		. name of structure
		  . meaning
		  . function
		. /all of the concept blocks/
		. parts and subparts

Processes	A process is some structure changing through time. The description of a process involves writing about what happens during successive stages of time.	. name of process . /all of concept blocks/ . /all of structure blocks/ . stage table . parts-function table . cycle chart . input-output table . cause-effect table . block diagram . PERT chart . WHIF chart . state table . condition . cause . effect

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MAP CLASSIFICATION CHART, continued

Types of Maps	Description	Information Blocks
Procedures	A procedure is a set of steps performed to obtain some specified outcome.	. name of procedure . /all of concept blocks/ . procedure table . flowchart . occasion for starting . when to stop . decision table . check list . work sheet
Classifi-cations	Classification is the sorting of things by concepts into categor-ies by the use of one or more sorting factors (criteria).	. classification table . classification sheet . classification list . outline
Facts	Facts are sentences about things done, things that are or were in existence, events, conditions, and so on, and are presented without supporting evidence.	. statement of fact
Proofs	Proofs are generally used in mathematical subjects for more dif-ficult theorems.	. name of proof . assumptions . to prove . statement . reason . example

APPENDIX B

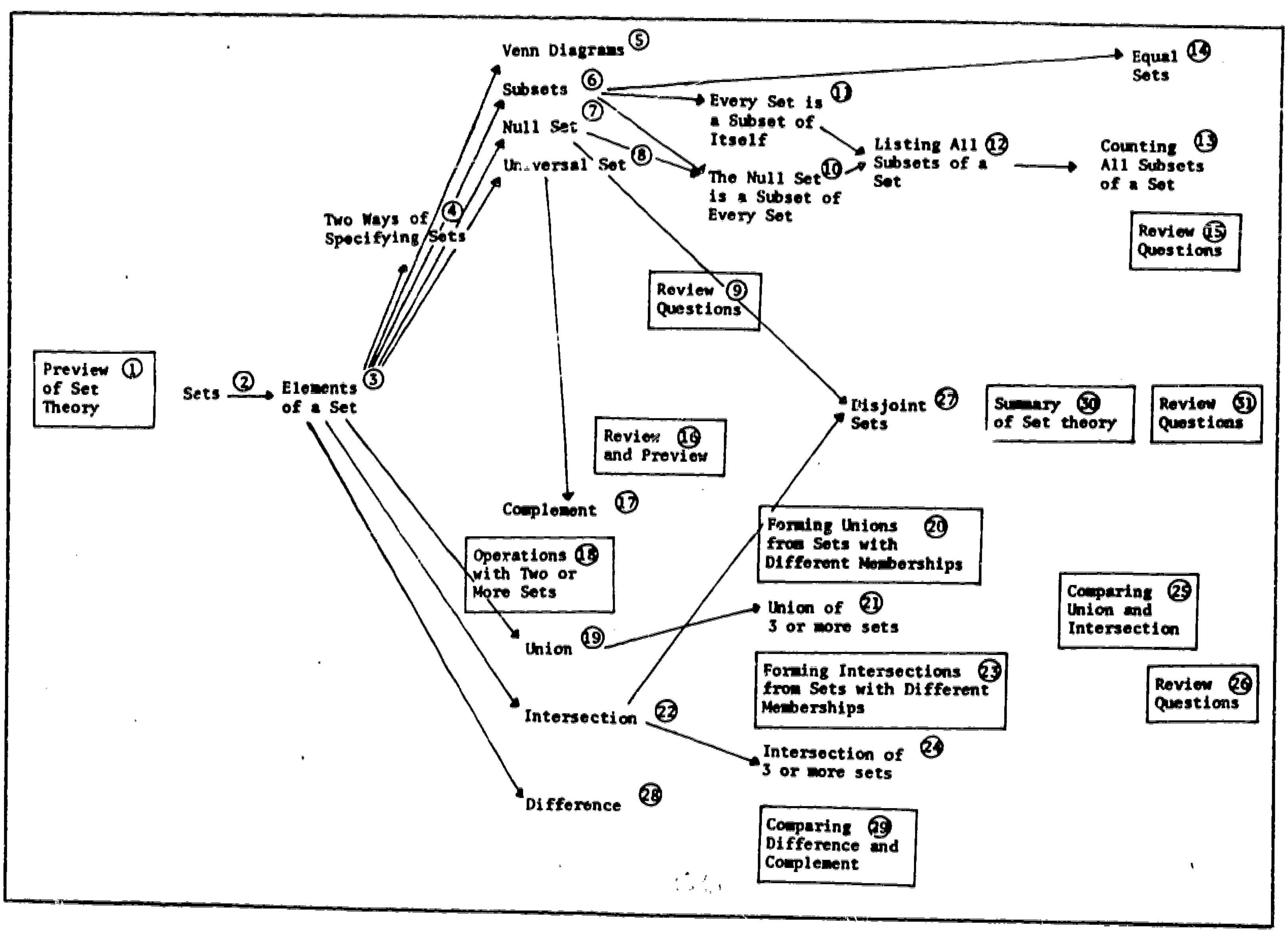
EXAMPLE OF A PREREQUISITE CHART *

Introduction

Before writing begins, the complete prerequisite chart (including the special learning materials) is drawn up. This chart functions as a road map for the writer, showing him the nature of his task and the character of the terrain that lies ahead. But the chart is not only important as a guide to the writer--it can also give the learner a clear idea of his learning task and of the direction the map presentations are heading. Therefore, prerequisite charts are included in information map books.

Example

The arrows are used to indicate the logical structure of the subject matter, i.e., the relationships among the concepts. The numbers refer to the teaching strategy or the sequence in which the topics are presented. The special learning and reference maps are shown in boxes.



* This and the following three maps are reproduced from: Information Mapping for Learning and Reference, Horn et al., 1969, ESD-TR-69-296.

EXAMPLE OF A PROCEDURE MAP

Introduction

This map shows the general case and the worked example side by side.

Example

HOW TO COMPUTE THE STANDARD DEVIATION

G I V E N	A set of n numbers $X_1, X_2, \ldots, X_n$	EXAMPLE. Find the standard deviation of the following test scores: 86,82,68,93,77,58,89,95,81,71
STEP	PROCEDURE	EXAMPLE
1	Add the given numbers to get the sum: ΣX_i	The sum of the ten test scores is $\Sigma X_i = 86+82+\cdots+71 = 800$
2	Square the sum and then divide by the number of cases to get: $(\Sigma X_i)^2/n$	$(\Sigma X_i)^2/n = (800)^2/10 = 640000/10$ $= 64000$
3	Add the squares of the given numbers to form ΣX_i^2	The sum of the squares of the test scores is $\Sigma X_i^2 = 86^2+82^2+\cdots+71^2 = 65234$
4	Subtract the result of Step 2 from the result of Step 3: $\Sigma X_i^2 - (\Sigma X_i)^2/n$	$\Sigma X_i^2 - (\Sigma X_i)^2/n = 65234 - 64000 = 1234$
5	Divide the result of Step 4 by the number of cases minus one to get: $S^2 = \dfrac{\Sigma X_i^2 - (\Sigma X_i)^2/n}{n-1}$	$S^2 = \dfrac{1234}{9} = 137.1111$
6	The standard deviation is the square root of the result of Step 5: $S = \sqrt{S^2}$	$S = \sqrt{137.1111} = 11.71$

160

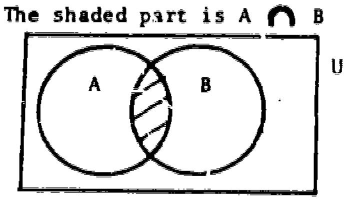
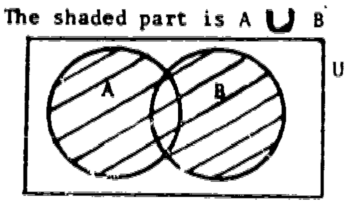
EXAMPLE OF A COMPARE-AND-CONTRAST TABLE

Introduction

We found that the distinction between the concepts of union and intersection was frequently missed by beginning students of set theory. Thus, the following map was written.

Example

40

COMPARING...	INTERSECTION AND...	UNION
Symbol	$\cap$	$\cup$
Definition	The intersection of two sets P and Q is the set of all members belonging to both P and Q.	The union of two sets P and Q is the set of all elements that are members of P or Q or both.
Venn Diagram	The shaded part is $A \cap B$ 	The shaded part is $A \cup B$ 
Example One	M = { 5, 9, 15, 33 } N = { 3, 5, 7, 9 } Notice this intersection, $M \cap N$ = { 5, 9 }	M = { 5, 9, 15, 33 } N = { 3, 5, 7, 9 } Notice this union, $M \cup N$ = { 3, 5, 7, 9, 15, 33 }
Example Two	E = { 1, 2, 3 } F = { 4, 5, 6 } Notice this intersection, $E \cap F = \emptyset$ (There are no common elements)	E = { 1, 2, 3 } F = { 4, 5, 6 } Notice this union, $E \cup F$ = { 1, 2, 3, 4, 5, 6 }

Related Pages: elements, 4 — union, 30 — intersection, 35 — set, 4

161

EXAMPLE OF A SUMMARY MAP

Introduction

This table was designed to tie up the topics related to conditional probability. Readers who are not familiar with the subject matter can nevertheless note several important features of the example. The introduction underlines the importance of the topic and suggests to the student the nature of his learning task. In the left column simple questions are paired with concrete examples to help the student remember the distinctions. Formulas are as usual accompanied by verbal descriptions.

Example

POSTVIEW OF CONDITIONAL PROBABILITY

Introduction

Conditional probability is one of the most useful tools in probability theory. We have seen how the equation can be rearranged to give the multiplication theorem and the independence definition, both important concepts.

The inter-relatedness of these ideas is a great boon to memory. If the conditional probability definition is thoroughly understood and stored in memory, it can serve as the key to unlock recollection of how the other formulas can be derived.

For review, we re-state the definition of conditional probability along with the concepts derived from it.

QUESTION	CONCEPT AND FORMULA
What is the probability of A, <u>given</u> that B has occurred? [Given a red-haired person, what is the probability that he has blue eyes?]	<u>Conditional Probability</u>: $P(A\|B) = \frac{P(A \cap B)}{P(B)}$ the conditional probability of A, given B = the probability that both events will occur divided by the probability of B
What is the probability that both A <u>and</u> B will occur? [What are the chances of winning Olympic medals in both track and swimming?]	<u>Multiplication Theorem</u>: $P(A \cap B) = P(B) \cdot P(A\|B)$ the probability that <u>both</u> events occur = the probability of B times the probability of A, given B
Are the events A and B <u>independent</u>? [Is the event "flunking math" independent of the event "flunking history?"]	<u>Independence Definition</u>: Two events are independent if and only if: $P(A \cap B) = P(A) \cdot P(B)$ the probability that both events occur = the product of the separate probabilities.
Given two independent events A and B, what is the probability that <u>both</u> of them occur? [If Tom and I both roll a die, what is the probability that we both get sixes?]	<u>Multiplication Rule for Independent Events</u>: [This is the independence equation just above.]

162

APPENDIX C

EXAMPLE OF A CONCEPT MAP

DIVISIONS OF A COBOL SOURCE PROGRAM *

Introduction	In leaving detailed instructions for anyone about carrying out a complex task, we commonly give them several types of information: we identify the task and ourselves first of all, then we say what pieces of equipment are to be used and how they are to be set up, and then we specify the kinds of materials that are to be processed or produced, and finally we explain the procedures to be followed. The computer too needs these same kinds of information in order to perform its tasks. The COBOL source program is organized to specify such instructions in a systematic way.
Description	A source program in COBOL has four divisions: . the Identification Division, stating the name of the program, its author, and probably the date . the Environment Division, telling about the equipment to be used, such as the specific computer (if the facility has more than one) and the various input-output devices . the Data Division, explaining what data items are going to be used and how they are arranged . the Procedure Division, setting out the steps that are to be followed in processing the data. In a COBOL source program these four divisions appear in the order given here.
Comment	The Data Division will be described next so that we may see first what sorts of "ingredients" are going to be worked on in the Procedure Division. In actual program writing, this is the order one would ordinarily follow. It is time enough to add identification and equipment information after the main idea has been worked out about how the procedures are to be applied to the data.

* COBOL, Cambridge, Mass., Information Resources, Inc., 1971 (draft), cited on p. 12.

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13. ABSTRACT

A new conception of computer-based instructional systems is presented in this design of a system that can deliver individualized information sequences not only to learners and trainees, but to reference workers, reviewers, browsers and the like. Underlying the system is a flexible data base, organized into labelled, movable information blocks according to the principles of Information Mapping--a system for categorizing and displaying information. This report is itself written in modified Information-Mapping style. A significant feature of this computerized information service is that the control over information selection and arrangement can be assigned entirely to the user, entirely to the system, or to both in one of many possible patterns of shared responsibility. When the system takes part in information-sequencing decisions, its many mechanisms for individualizing come into play. The executive program consults short-term and long-term data about the individual, his objectives, capabilities, interests and present status before it selects and arranges blocks from the data base to display for him. Evaluation and feedback provisions are also individualized. The system's capability for controlling conditions and recording user-system interactions will make it a valuable force in research on individualization in training and education. The development of this complex design was facilitated by a Documentation-Updating System that produced system documents in Information-Mapped form and kept them up to date throughout the project.

166

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Information Mapping						
education						
learning						
training						
reference						
programmed instruction						
programmed learning						
computer-aided instruction						
computer-assisted instruction						
computer-managed instruction						
computer displays						
information retrieval						
human factors						
human engineering						
man-computer interaction						
computer-aided reference						
documentation procedures						
updating procedures						
computer documentation						
Information-Mapped data base						
individually prescribed instruction						

Security Classification

Predecessor Research
1966

A Terminal Behavior Locator System

By
Robert E. Horn
Institute of Educational Technology, Teachers College,
Columbia University
(From *Programmed Learning*, No. 1, February 1966.
The Eastern Press Ltd., London and Reading)

Author's Note
In this early paper I introduce for the first time the major classifications system that underlies my approach to structured writing (further developed in Information Mapping's method). The context is "programmed learning," which is what I was doing research on in 1963-65.

Important to note is that this is the first clear separation of information into information types in Information Mapping/structured writing and its later formulation (CF3P).
- Concepts
- Structures
- Procedures
- Processes (called operations in this article)
- Facts (called "paired associates" in this article)
- Classifications

These distinctions still form the basis for developing chunks of information in most structured writing approaches.

Introduction
Theory, practice and research in verbal programmed instruction would be advanced greatly if we had a useful and fairly comprehensive set of categories for describing terminal behavior. One way of approaching the construction of such a typology of terminal behavior is by classifying the terminal or criterion frame itself. By terminal frame I mean simply test items, whether they appear at the end of sequences, as review or practice items, or as post-test items. A classification system for terminal items, in fact, would seem to be central to the concerns of any type of instructional system. Given a classification of terminal frames, it is a fairly easy step to the classification of the types of sequences preceding them. Given a set of terminal frames, it is a simple matter to construct the objectives for a given course. Any useful categorization of terminal behavior frames should make it that much easier to teach novice programmers this particular aspect of programming. When one is about to write any terminal frame for a program, it would be much easier to "look it up" in a locator index than to conceive each one anew. In short, a classification may contribute to making programmed instruction more of a technology than it now is.

This paper presents such an attempt to classify terminal or examination items for verbal instructional systems. Non-verbal terminal behavior is not a concern in this paper and is

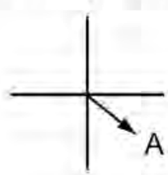
not discussed. The re-classification of what we have been doing in PI has already been shown to be useful in the area of branching technique (Horn, 1963a).

In this typology the general framework for classification is based on my paper “Systematic Task Analysis” (Horn, 1963b), in which I used a modification of the classification system of Upton and Samson (1961) to structure the verbal tasks included in a given job or subject-matter field. Briefly these are concepts, structures, procedures, operations, classifications and hierarchical organization. The typology is also based upon the form of questions rather than upon their content. Non-numerical matrices have been constructed to work as a kind of net which can be dragged through a given subject-matter, catching and organizing the pertinent terminal behavior in the process.

Terminal Frames For Concepts

A useful place to start with the classification of terminal frames is with the concept. A concept can be defined as a generalization within a class and a discrimination among classes. Concepts frequently (though not always) have names, can be defined or described, and instances and non-instances of them can be given. Table 1 illustrates the types of verbal information we have to deal with in constructing terminal frames on a given concept-cluster.

TABLE 1

Name of Concept:	Vector.
Definition of Concept:	(1) An ordered ser of two or more numbers. (2) A quantity having magnitude and direction.
Instances of Concept:  	(1) (7,0-5, X,Y,) is a vector. So is (3.7). Often represented on a co-ordinate system by means of a line from the origin to the point represented by the set of numbers. In the diagram, Vector A is represented by the numbers (2, —2). (2) 23 miles per hour South 40 pounds of force down.
Significant Non-Instances of the Concept:	Any scalar, such as 13 miles, 43lb., 63°.

We can take the various parts of a concept-cluster (the name, definition, instances and non-instances) and arrange them on two axes of a matrix as shown in Table 2. The vertical column on the left is the “Given” column, which describes what parts of the concept-cluster are given as part of the stimulus. The horizontal column at the top is the “Do” column, which describes what verbal behavior must be produced as a response by the student.

TABLE 2			
Given ↓ *Do* →	*1 Name*	*2 Definition*	*3 Instances Non-Instances*
A. *Name*	What is another name for a . . . ? What is a synonym for . . . ?	Define . . . _____ What is a . . . _____ List/number/characteristics of a . . . _____ What is the technical definition of a . . . _____ What is meant by . . . _____	List/number/examples of a . . . _____ Give/number/examples of a . . . _____ List one example of a . . . and one thing which is often confused with it. _____
B. *Definition*	A/definition/is a . . . _____ The technical term for a . . . is _____	What is another definition for the term defined above? _____	List/number/examples of a . . . _____ etc.
C. *Instances*	*Instance(s)* What is this called? _____ What is the technical term for the example above? _____ Non-Instance(s) What are often confused with the examples above? _____	*Instance(s)* What are the main characteristics of these? ___ What is the general description of these things? _____ How do you describe these? _____ How do you define these? _____	*Instance(s)* Give/number/other examples of the same kind of thiing. _____
D. *Instance(s) Non-Instance(s)*	*Instance(s)-Non-Instances* Label each of these. _____ What is the technical term for each of these? _____	*Instance(s)-Non-Instances* How are these different? _____ How are these the same? _____ In what respect do these differ? _____ In what respect are these the same? _____	*Instance(s)-Non-Instances* Give/number/other examples of each kind. _____

For example, let us examine the first horizontal row of terminal frame forms for the concept-cluster of the borrowed or loan word, which is a word taken (usually intact) into one language from another language. First of all, we can notice that there are two names for the same concept. So that it is possible to write a terminal frame of the form:

What is another name for a borrowed word? ________________________________

The reverse, of course, is also possible as a terminal frame. We can contemplate asking the student:

Define the term "borrowed word." ____

Continuing across the top row to the right, we can ask the student to:

List two examples of borrowed words from the preceding sequence. ______________

The last frame may not be acceptable to us as a terminal frame for our program for a variety of reasons, but our locator system aids us by stating that it is a possible terminal behavior which we can accept or reject.

Notice that in each of the frames on this row the part of the concept-cluster that was given to the student as a part of the stimulus was the name of the concept. Dropping down to the second horizontal row of frame forms, we notice that what is given to the student as part of the stimulus is the definition, which yields these frames:

A word that is taken (usually intact) from one language into another is called a ____________________.

"Words taken (usually intact) from one language into another." What is another way of defining or describing what is defined above?____________________

List five examples of words taken (usually intact) from one language into another. ____________ ______________ ______________ _______________ _______________

Clearly the second frame of the above group is not as good used as a terminal frame for *this* concept as it might be for others. This, then, is how the terminal frame locator system specifies the kinds of possible frames that can be asked about a given concept-cluster.

There is another important distinction that has to be made with regard to terminal behavior; this is the difference between asking the student to construct or to pick out an answer. It is still a researchable matter as to how much difference can be attributed to recall as required by the terminal frames constructed from Table 2 and the recognition required by the terminal frames constructed from Table 3. But as a practical matter of program writing, one has to recognize the difference as a difference in frame form. Thus, Table 3 repeats the same categories on both axes, but the frame forms, we notice, require only that the student examine several possible answers and check the appropriate response. For reasons of length, we will not give examples of each of these frame forms in Table 3.

TABLE 3			
Given ↓ *Do* →	*1 Name*	*2 Definition*	*Instances* *3 Non-Instances*
A. *Name*	Check which of the following is another name for . . . ____	Check which of these is the correct formal definition of . . .	Check which of these is a . . . Place a check mark before each of the following which is a . . . Complete the table below by checking which of the . . . is a . . . or a . . . Classify the examples by completing this table . . .
B. *Definition*	Check which of these is defined as . . .	Check which of the following is another correct definition for the term defined above.	Check which of the following is described as . . . Check which of the following is technically defined as . . .
C. *Instance(s)* *Non-Instance(s)*	*Instance(s)* Check which of these is the correct name/term/for the example(s) above.	*Instance(s)* Check which of these definitions is the one which correctly defines the examples above. Which of these best describe the examples above?	*Instance(s)* Check which of these are examples of the same kind of thing as illustrated above/listed above.
D.	*Instance(s)-Non-Instances* Match the names above to the examples below.	*Instance(s)-Non-Instances* Check which of these describes the similarities and/or differences in the examples above. Match the example to the definition	*Instance(s)-Non-Instances* Match the things listed above with the things listed below.

An examination of the frame forms at levels C-2, D-2, C-3 and D-3 will show that while these are terminal, they call for a kind of terminal behavior that is significantly different from the kinds in the other cells on levels A through D, which call for discrete already learned information. The frame forms in C-2 and D-2, Table 2, call for what may be described as "abstracting" behavior. The student is called upon to notice and describe the qualities of things presented in the "instances" portion of the frame and to describe the similarities and differences he sees.

C-3 and D-3, Table 2, also may be terminal frames but they call for behavior which demands a good deal of general experience. If I list five things and ask you to give me five more examples of the same kind of thing which I have not taught you, I am asking

for a great deal more than if I ask you merely to repeat the examples you have just learned in a learning sequence.

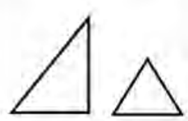
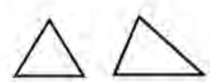
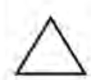
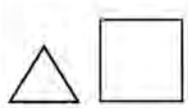
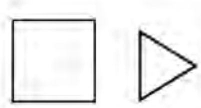
We may, of course, also examine each of the frame forms for how easy it will be for the student to check the type of answers that are required of him by the frame. It is more difficult to provide *precise feedback* in some frame forms than it is in others.

Terminal frames for structures

A structure is something which has boundaries and parts which can be identified. Some examples of structures are: the human body, machines, environment of all kinds, systems of diagramming and notation.

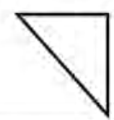
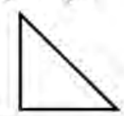
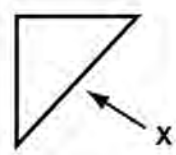
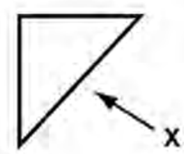
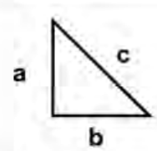
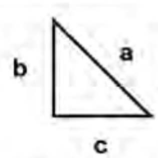
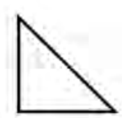
Table 4 shows how the terminal frame forms can be applied to a structure, the triangle. The frame forms which did not yield useful terminal frames have been left blank on Table 4. An important thing to note about structures is that diagrams are nearly always necessary in terminal frames dealing with structural concept-clusters, as, indeed, diagrams are necessary in *teaching* the structural concept-cluster.

TABLE 4

Given ↓ *Do* →	*1 Name*	*2 Definition*	*3 Instances Non-Instances*
A. *Name*		What is a triangle?	Draw a triangle
B. *Definition*	A three-sided closed figure with three angles is called a _______.		Draw a three-sided closed figure with three angles
C. *Instances*	 What is the name of the figures above? _________	 Describe the figures above .	 Draw another figure like the one above.
D. *Instances Non-Instances*	 Label each of the figures above with their names	 How are the figures above similar and how are they different? _____	

Structures have parts. Parts can also form a concept-cluster as is illustrated by Table 5.

TABLE 5

Given ↓ *Do* →	*1 Name*	*2 Definition*	*Instances* *3 Non-Instances*
A. *Name*		Define "hypotenuse."	Draw an arrow to show the hypotenuse. 
B. *Definition*	The side of a right-angled triangle that is opposite the right angle is called a ________.	The side of a right-angled triangle that is opposite the right angle. Give another description of the term defined above.	Draw an arrow to show the side which is opposite the right angle. 
C. *Instances*	 What is the side labeled "x" called? ____________	 Describe the side labeled "x."	
D. *Instances* *Non-Instances*	 Label each of these sides.	 Describe how these sides are different or similar . . .	 Draw arrows to show where the hypotenuse ends.

It is useful to note that many terminal frames for programs will be multiples of the basic frames in the locator system. A frame such as the following is an example of a "multiple":

Draw the bones of the hand and label each class of bones.

A special kind of terminal frame of the "multiple" category is the "multiple discrimination" frame where the behavior required is the distinguishing between two concept-clusters which "compete" in some fashion (Gilbert, 1962). An example of such a terminal frame is:

Label each of the following either “vector” (V) or “scalar” (S). _____ 2 miles up _____ 14 litres _____45 mph _____ 1 7/8 inches per second _____ 3 feet _____19 pounds of force down

Terminal frames for procedures
A procedure is a set of steps which a person performs to obtain a specified outcome. Some examples of procedures are: a problem to solve, a machine to turn on, a set of steps to follow in a selling situation, a rearrangement of the parts of something, a game to play. Typically, procedures can be placed under “How to” titles such as “How to Turn on the Model 913 Sprayer,” “How to Read and Interpret Bar Graphs,” “How to Trouble Shoot PXY Equipment,” “How to Write Programs for the 9905 Computer,” “How to Solve Square Root Problems,” “How to Decide Whether to Make or Buy a Part,” “How to Plan a Pert Network for a Project.”

Each step in a procedure may include or be a concept-cluster and, of course, procedures may involve the use of structures, so that subterminal frames may be found by using previous tables. But typically the overriding terminal behavior involved in procedures is found in Table 6.

The occasion upon which you use a procedure is an important concept-cluster for each procedure. It may be spelled out using Table 2.

TABLE 6

Given ↓ *Do* →	1 *Name*	2 *Definition* (List of Steps)	3 *Example* (Problems to Solve)
A. *Name*		List in order the steps for solving square root problems. _______________	What is the square root of 23? _______
B. *Description*			Here are the steps for solving the problem below. 1. Take the . . . 2. Etc. Solve the problem. $\sqrt{23}$
C. *Instances*	$\sqrt[2]{4}$ What is this process called? _________		

Terminal frames for operations
An operation is the change in some structure during an interval of time (usually for some specifiable purpose). Some examples of operations are: the movement of a machine, the changes in weather in the atmosphere, the systematic functioning of the brain. The

terminal frames for sequences that teach operations must be arranged into separate matrices of the various stages of the operation, the parts of the structure involved at each stage and how each part functions, the occasion for the beginning of the operation and the result of the operation. I will not burden this article with the large number of Tables that would be involved in showing terminal behavior for teaching operations.

Terminal frames for paired associates
Another class of terminal frames comprises all of those frames which ask for a response that may be called "paired associates." Examples of such frames are:

Columbus discovered America in ____________.

" £" is a symbol for ____________________.

What percentage of the total labor force was unemployed in April 1962 ________.

Terminal frames for classification
Classification has to do with the *kinds* of things. In specifying terminal behavior, we ask such questions as:

What sorts of terminal frames are there? ___________

List six major kinds of terminal frame classifications for verbal programmed instruction.
__________ ___________ ____________ ___________ ____________ ___________

What are the sorting factors used in the classification? _____________________

What is the purpose of this classification? _______________________

Using the terminal frames in five programs, make up a classification system for them and give the classes names.

Conclusions
The terminal behavior locator system described in this paper may be used to classify the types of teaching sequences preceding each terminal behavior. Perhaps we cannot specify all of the frame forms which must precede a given terminal frame. That need not deter us. The approach which I suggest is the specification of necessary "sub-terminal" frames and "key" teaching frames. I think these two kinds of frames can be specified in a

more or less exact fashion. Then the writer's judgment and knowledge of the subject-matter and the student can be brought to bear on the remaining "transitions."

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